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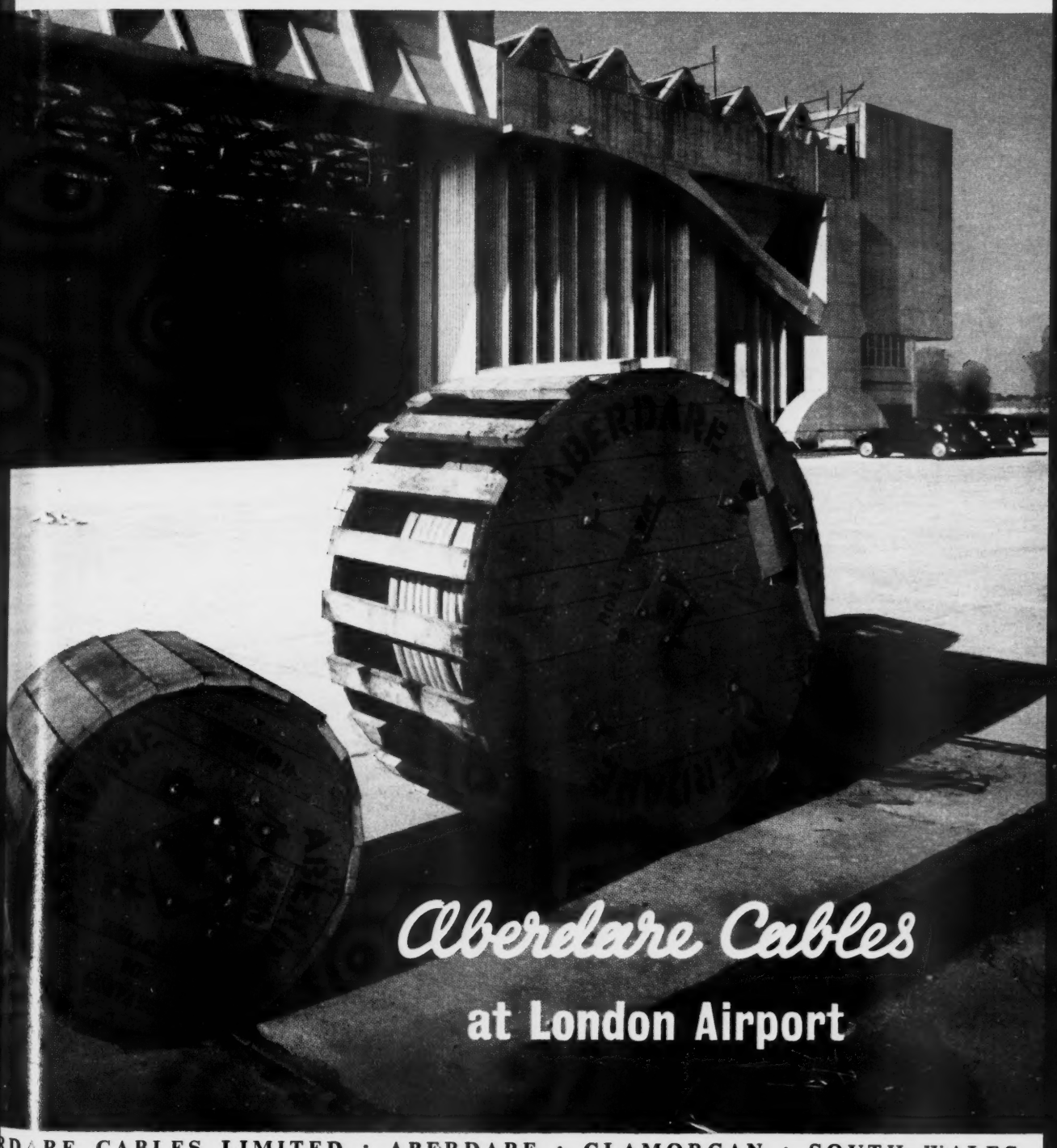

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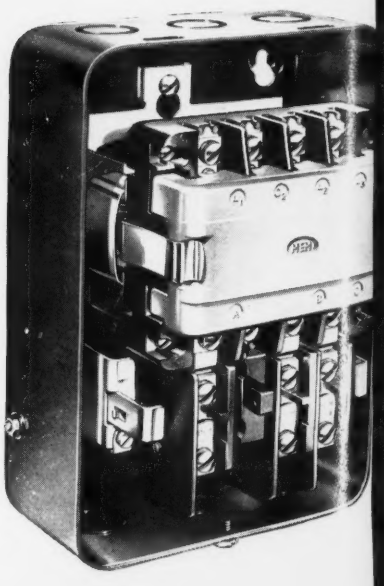

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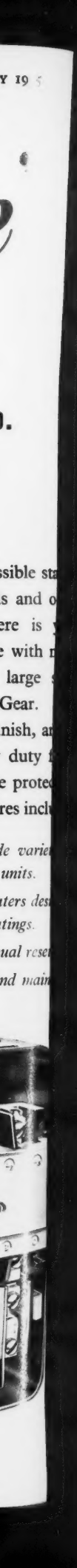

ELECTRICAL REVIEW

Managing Editor: HUGH S. POCOCK, M.I.E.E.
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20 MAY 1955

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VOLUME 156 ✧ NUMBER 20

Eighty-Third Year of Publication

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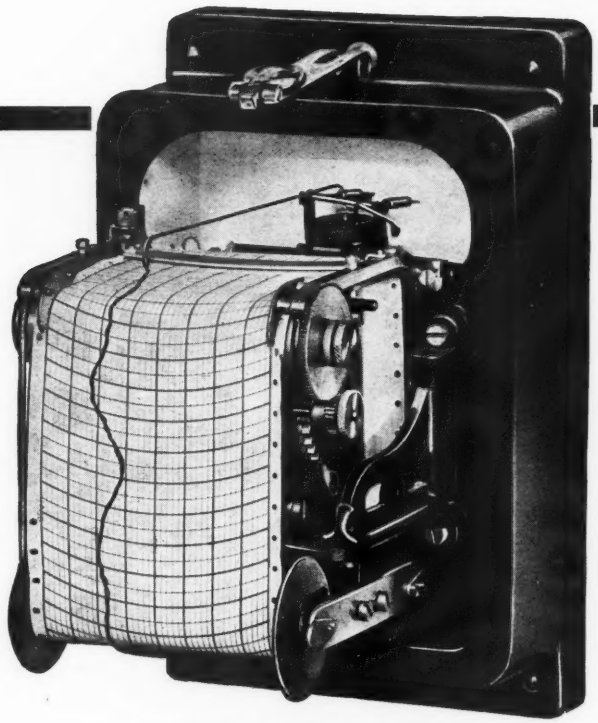

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ELECTRICAL REVIEW

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Load Factor Improvement

SOMETIMES (probably too often) the technical and commercial sides of the electricity supply industry regard themselves as quite separate communities. This is a fallacy, for they have the common aim of providing the public with all the electricity it needs at as low a price as possible. Technical efficiency is only the means to that end and not an end in itself. The engineers of the Central Electricity Authority have done well, as Sir John Hacking mentioned at the annual luncheon of the British Electrical Development Association last week. In 1953–54 the overall thermal efficiency of the C.E.A. power stations was 23·4 per cent and Sir John expected it to exceed 26 per cent by 1960. Some of the plant now under construction will reach a net thermal efficiency of 28 per cent and, of course, the total figure will rise as the older plant is replaced.

Unfortunately the saving in operating costs thus achieved will be largely offset by the higher capital charges on the newer plant, but in spite of this electricity will remain good value for money. It is the task of the commercial men of the Electricity Boards to convince the public of this fact and secure a better loading of the more efficient plant.

When generating plant was inadequate the lopping of the load-curve peaks was essential; now it seems to us that the filling of the valleys is more important. Sir John Hacking said that the national load factor actually tended to fall; it was below 44 per cent in 1953–54 while the United States load factor was 60 per cent or more. Only a substantial new night load can put us on a level with the Americans. There are means of encouraging domestic consumers to go in for night-time water heating but the necessary control equipment is somewhat costly. Nevertheless the subject deserves further study.

But it is not the domestic consumer whose curve needs the most straightening out. Sir John showed that under present arrangements the industrial load factor could not possibly be more than 26 per cent. It is from industry and commerce that improvement must mainly come. We suppose that most industrialists would be glad to see a better loading of their productive plant but their employees, with good reason as things are, do not favour 24-hour working or even a two-shift system. To alter their views would mean a revolution in the ideas of transport and catering concerns; in fact to encourage regular general night work night would virtually have to be turned into day. With the growing predominance of the machine and automatic control the problem is diminishing but it still exists and means of meeting it should be sought. There is also a need for dwellers in rural communities to make better use of the expensively-provided service—a job for salesmen with full knowledge of farming and rural industries. The services of E.D.A. to the electricity supply industry in the pursuit of these aims are comprehensive and invaluable.

GERMAN RE-ARMAMENT

Since the end of the war Germany has been free of the burden of armaments although, of course, she has had to meet the cost of the occupation forces. Now that the situation is about to be altered German industrialists are anxious about the effect upon their costs of the taxation which armaments will necessitate, particularly as it concerns export trade. Another aspect is the amount of skilled labour which will have to be diverted to armament production as this may possibly affect delivery periods, a direction in which German exporters have often had an advantage over the British. These points are of considerable interest to British electrical exporters now that Germany is again becoming a formidable rival in world markets. In the opinion of the Federation of German Industry the resumption of armament manufacture will not impose an unbearable strain if it is of a gradual character and is operated in such a way as to fit in with the country's economy generally. It will be necessary, however, to arrange for the recruitment and training of more men for skilled work as the present schemes were designed for civil production only.

INDUCTION HEATING OF INGOTS

The description in this issue of the induction heating installation for the heating of ingots at the Vancouver Mills of Western Canada Steel, Ltd., seems to us to suggest a tremendous step forward in the function of materials handling and flow line production. The passage of the ingots end to end in a continuous stream through a tube or coil tunnel appears to take the place of batch production operation of, say, the soaking pit, the pre-heating furnace and the annealing furnace. A speed up of ingot heating time from 45 minutes in the case of a fuel-fired furnace to 8·4 minutes of induction heating time is a great advance which, if it does not mean an increase in overall plant output, will certainly mean a considerable saving in " stalling " time along the line. We incline to the view that the greatest value of the scheme lies in the ease with which the ingots can be moved along the production flow line, an invaluable aid to production which has been afforded by materials handling methods in so many instances in the fields of light engineering. Then, of course, there is the immense importance to the electrical industry of the potential demand on the supply section and of the call on the manufacturing section not only for the actual heating equipment but for the high frequency alternator sets and switch and control gear.

SHORTAGE OF TECHNOLOGISTS

For two consecutive years a dominating feature of both the annual report of the Institution of Electrical Engineers and the President's speech at the I.E.E annual dinner has been a warning that the rate at which young electrical engineers are joining the Institution is inadequate to the national needs for professionally qualified electrical engineers. Such reiteration is a measure of the seriousness of the state of affairs and the need for immediate strong measures to remedy this. It is as well, of course, that the industry itself should know of the gravity of the position but it is essential to make it known outside. It is satisfactory to learn from the annual report that appeals are being made to school children and parents, that discussions have taken place with the national education authorities and that the considerable misgivings felt at the Minister of Education's reluctance to accept the advice offered by the three leading engineering institutions on future development of technological education has led to representation by the three Institutions to the Minister.

COLOMBIAN TRADE

From an article dealing with electrical and industrial development in Colombia it will be seen that that country's imports of the principal classes of domestic and other electrical equipment in 1953 were valued at about £12 million. The British Board of Trade returns for that year gave British electrical exports to Colombia as £241,831; last year the figure rose substantially, to £343,608. Colombia is short of power but has ample water resources as well as coal and oil. American influence is strong, as will be gathered from the article; the lion's share of imported electrical goods emanated from the United States. France also loomed large on account of the equipment for the Paz de Rio steelworks. Nevertheless last year's expansion of British electrical exports to the country indicates that there are trade possibilities there and it may be worth while for British electrical manufacturers and exporters to examine them.

SOUND AND ADEQUATE

Electrical development is badly hampered by ill-designed installations. It is difficult to persuade people to buy appliances if their use involves expensive additions to their wiring. Worse still, inadequate installations lead to all kinds of " amateur " work and long runs of unprotected flex. Most of the trouble arises from the desire of housing authorities, architects and builders to keep costs down—a penny-wise policy which can only be changed by the electrical education of those concerned. In so far as electrical contractors have any influence in the matter they will be greatly helped by a set of specifications for the wiring of small dwellings drawn up by the Electrical Contractors' Association for the use of its members. These can be brought to the notice of those responsible for the design and erection of the dwellings at the time of tendering. The proposals are practicable and reasonable.

VARIED APPLICATIONS

Interesting applications of electricity are embodied in the man-carrying centrifuge at the R.A.F. Institute of Aviation Medicine, Farnborough, which is described in this issue. In the first place the main drive is an outstanding example of heavy engineering variable speed driving by which the speed of the large directly coupled motor can be accelerated to produce a peripheral speed at the end of a 60ft diameter rotating structure of 115 m.p.h., at which speed a centrifugal force equivalent to 30 g is obtained. In this achievement, the fine variable speed control (Ward-Leonard) is reinforced by an overall electronic control. Electronics play an important part in the electro-medical features of the equipment by which the physiological reactions of the subject to high-speed changes are measured and recorded.

Industrial Capacitors

Application of Chlorinated Diphenyls

By P. D. WILMOT, B.Sc.*

WHERE capacitors of long life, high voltage and large capacitance are required the impregnated paper dielectric capacitor is employed. Up to recent years mineral oil has been used as the impregnant, but it is being replaced more and more by synthetic materials; of these the most important are the chlorinated diphenyls.† Although it is only during the last three years that these fluids have been produced commercially in the U.K.,[1] in America they have been available as capacitor impregnants for the last twenty years, and their employment has led to very considerable advances in capacitor production, design and application.

In a previous paper[2] measurements of permittivity, power factor and breakdown strength were reported for a range of these compounds, and a brief mention was made of the significance of these results to capacitor design. In this article the behaviour of paper dielectric capacitors impregnated with chlorinated diphenyl will be described.

Capacitor Windings

It is usual in the construction of this type of capacitor to interleave paper and metal foils and wind these as shown in Fig. 1. Something like half of the space between the foil electrodes is air and its relatively low breakdown strength allows the use of only very low voltages or very wide electrode spacings. The resultant permittivity of the paper-air dielectric is also low and a prohibitively large volume of winding would be required for most applications. It is therefore desirable to impregnate the winding with a fluid or a wax of high dielectric breakdown strength and permittivity, and it is possible to obtain a mathematical expression relating these two properties to capacitor size.

A good capacitor paper should be thin and of a high degree of uniformity in thickness. In the process of achieving this, the fibres are flattened and brought into close contact with each other to produce pores whose axes lie to a very great extent in the plane of the paper, as is proved by its low porosity.[3, 4] These pores are almost entirely filled with the impregnant by the process of vacuum impregnation and the volume fraction of pores, *i.e.*, impregnant in the paper can be obtained from a knowledge of the bulk density of the paper and the density of cellulose itself:—

$$\theta_p = \frac{\rho_o}{\rho_c} \quad .. \quad .. \quad .. \quad .. \quad (i)$$

$$\theta_i = 1 - \frac{\rho_o}{\rho_c}$$

where θ_p is the volume fraction of paper fibre, θ_i is the volume fraction of impregnant, ρ_o is the bulk density of the paper, and ρ_c is the density of cellulose.

The impregnated winding may be regarded as a flat plate capacitor, since the area/gap ratio is large. Any line of force from plate to plate will traverse alternate regions of paper fibre and impregnant, and since the pores are numerous and distributed throughout the dielectric the ratio of total thickness of impregnant to total thickness of fibre traversed will be constant for the entire surface. The paper may thus be regarded as a composite dielectric of two media, impregnant and paper fibre, disposed in series between the plates. The resultant permittivity of this dielectric is therefore obtained from:—

$$\frac{1}{\epsilon^1_o} = \frac{\theta_p}{\epsilon^1_p} + \frac{\theta_i}{\epsilon^1_i} \quad .. \quad .. \quad .. \quad (ii)$$

where ϵ^1_o is the permittivity of the whole dielectric, ϵ^1_p that of the paper fibre, and ϵ^1_i that of the impregnant.

Experimental evidence is available to verify this. Endicott, Race and Hemphill[5, 6] have examined paper before and after impregnation with impregnants ranging from mineral oil to semi-conductors, whose permittivity is infinite. By applying formula (ii) a very close agreement with the series theory was obtained, a slight deviation being due, in their opinion, to sheet thickness variation. Renne[3] too, has found in similar measurements that the series hypothesis is essentially correct; in this case, impregnation was not complete and a content of air had to be taken into account.

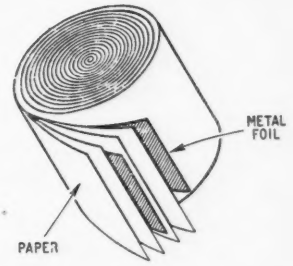

Fig. 1.—Paper dielectric capacitor winding

To achieve the smallest size the capacitor should have the smallest possible electrode separation, and ideally the gap should be arranged so that with the working voltage the field strength is slightly below the breakdown strength of the capacitor dielectric. The dielectric is composed of paper and impregnant, and since the breakdown strength of cellulose is very high the limiting factor will be the dielectric breakdown strength (b.d.s.) of the impregnant.

We must therefore ensure in the ideal capacitor that the impregnant layer is stressed to just below its b.d.s.:—

$$E_1 d_1 = V_1 \quad .. \quad .. \quad (iii)$$

where E_1 is a field strength slightly below the b.d.s. of the impregnant, d_1 is the thickness of the equivalent impregnant layer, and V_1 is the voltage applied to the equivalent impregnant layer.

The voltage applied to this layer is obtained from the expression for potential division by series capacitors:—

$$V_1 = \frac{V_o C_o}{C_1} \quad .. \quad .. \quad (iv)$$

where V_o is the working voltage of the capacitor, C_o is the capacitance of the whole capacitor, and C_1 is the capacitance

---

* Monsanto Chemicals, Ltd.

† Produced at Newport, Mon., by Monsanto Chemicals, Ltd., and sold under the Registered Trade Mark "Aroclor."

of the equivalent impregnant layer. Since we are dealing with a flat plate capacitor:—

$$C_1 = \frac{A_o \epsilon^1_1}{4 \pi d_1} \quad .. \quad .. \quad (v)$$

where A_o is the area of the electrode, and ϵ^1_1 is the permittivity of the impregnant.
Combining (iii), (iv) and (v):—

$$A_o = \frac{4\pi V_o C_o}{\epsilon^1_1 E_1} \quad .. \quad .. \quad (vi)$$

It is seen that for a given rating, capacitor foil area is inversely proportional to the product of breakdown strength and permittivity of impregnant.
For a 0·1 μF capacitor operating at 500 V a value of:—

$$A_o = \frac{5{\cdot}7}{\epsilon^1_1 E_1} \quad 10^4 \text{ sq cm} \quad .. \quad (vii)$$

is obtained, where E_1 is expressed in kV per mm. This relation has been plotted as a function of ϵ^1_1 in Fig. 2 for a breakdown strength of impregnant of 20 kV/mm.

By using impregnants of higher permittivity economies can also be achieved in the volume of dielectric required. The quantity of paper is $A_o d_p$, where d_p is paper thickness. By equation (i) d_p may be expressed as:—

$$d_p = \theta_p d_o \quad .. \quad .. \quad (viii)$$

where d_o is the thickness of the entire dielectric.

We can express d_o in terms of the parameters of the complete capacitor:—

$$d_o = \frac{A_o \epsilon^1_o}{4 \pi C_o} \quad .. \quad .. \quad .. \quad (ix)$$

A_o we already know from (vi) and ϵ^1_o is obtained from (ii), so by substitution we can express d_o and, in turn, d_p in terms of E_1, ϵ^1_1 and volume fractions of dielectric present:—

$$d_p = \frac{V_o \epsilon^1_p \theta_p}{E_1 (\epsilon^1_1 \theta_p + \epsilon^1_p \theta_1)} \quad .. \quad (x)$$

By (i) this can be related to paper density:—

$$d_p = \frac{V_o \rho_o \epsilon^1_p}{E_1 (\epsilon^1_1 \rho_o + \epsilon^1_p \rho_c - \epsilon^1_p \rho_o)} \quad .. \quad (xi)$$

Hence paper volume is:—

$$A_o d_p = \frac{4 \pi V_o^2 C_o \rho_o \epsilon^1_p}{E_1^2 \epsilon^1_1 (\epsilon^1_1 \rho_o + \epsilon^1_p \rho_c - \epsilon^1_p \rho_o)} \quad .. \quad (xii)$$

The total volume of impregnant is $A_o d_1$ and by equation (i):—

$$d_1 = d_p \left(\frac{\rho_c}{\rho_o} - 1\right) \quad .. \quad .. \quad (xiii)$$

Therefore to obtain the total volume of impregnant all that is necessary is to multiply $A_o d_p$ by the factor $\left(\frac{\rho_c}{\rho_o} - 1\right)$:—

$$A_o d_1 = \frac{4 \pi V_o^2 C_o \rho_o \epsilon^1_p}{E_1^2 \epsilon^1_1 (\epsilon^1_1 \rho_o + \epsilon^1_p \rho_c - \epsilon^1_p \rho_o)} \left(\frac{\rho_c}{\rho_o} - 1\right) \quad (xiv)$$

The total volume of dielectric is therefore:—

$$A_o (d_i + d_p) = \frac{4\pi V_o^2 C_o \rho_c \epsilon^1_p}{E_i^2 \epsilon^1_1 (\epsilon^1_i \rho_o + \epsilon^1_p \rho_c - \epsilon^1_p \rho_o)} \quad (xv)$$

With a total thickness of:—

$$d_o = d_1 + d_p = \frac{V_o \rho_c \epsilon^1_p}{E_1 (\epsilon^1_1 \rho_o + \epsilon^1_p \rho_c - \epsilon^1_p \rho_o)} \quad (xvi)$$

From this expression we can obtain the maximum stress possible as a function of permittivity and breakdown strength of impregnant and density of paper:—

$$\frac{V_o}{d_o} = \frac{E_1 (\epsilon^1_1 \rho_o + \epsilon^1_p \rho_c - \epsilon^1_p \rho_o)}{\rho_c \epsilon^1_p} \quad .. \quad .. \quad (xvii)$$

We have thus obtained expressions for dielectric thickness and volume, which show that size can be reduced if the permittivity and breakdown strength of the impregnant are increased. The actual extent to which this may be done depends on paper density; for a 0·1 μF capacitor operating at 500 V with a paper density of unity, we obtain the following expression for total volume of dielectric:—

$$\frac{2{\cdot}8}{E_1^2 \epsilon^1_1 (\epsilon^1_1 + 3{\cdot}3)} \quad 10^4 \text{ cu cm} \quad .. \quad .. \quad (xviii)$$

where E_1 is expressed in kV per mm and values of 6·6 for ϵ^1_p and 1·5 for ρ_c have been assumed. This relation has been plotted in Fig. 2 for a breakdown strength of 20 kV/mm.

The foregoing expressions are idealized, for in fact one must increase electrode spacings beyond what would be required by the formula. This is to allow for surge effects and internal heating under the high stresses. Nevertheless savings can be and are made in the direction of electrode separation by using impregnants of higher permittivity and breakdown strength.

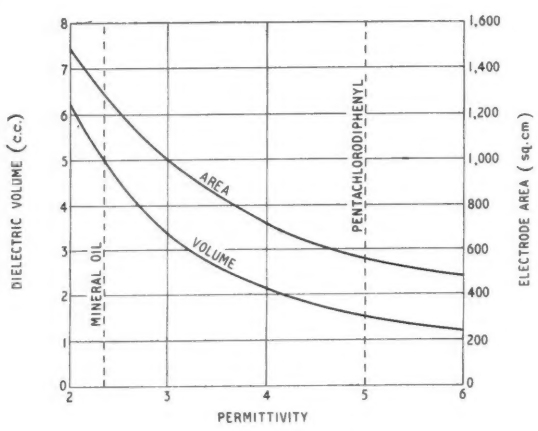

Fig. 2.—Relation between permittivity of impregnant and the dimensions of the ideal capacitor

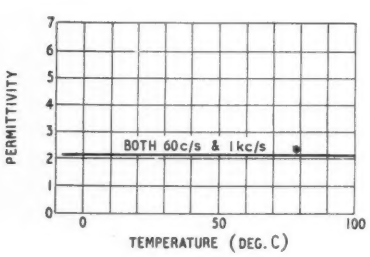

Fig. 3
Permittivity of mineral oil

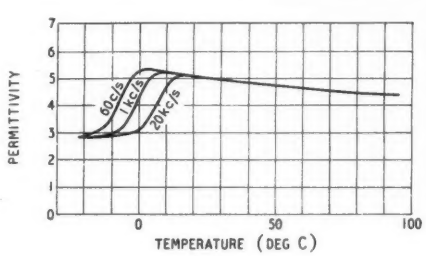

Fig. 4
Permittivity of pentachlorodiphenyl (Aroclor 1254)

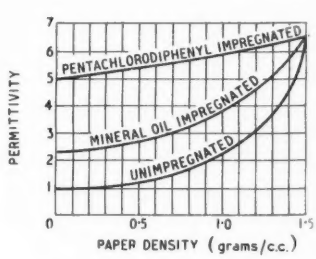

Fig. 5
Effect of paper density on the permittivity of impregnated paper at 20 deg C

Fig. 6.—Short-time breakdown strength of paper impregnated with pentachlorodiphenyl

Fig. 7.—Method of finding the ionization field strength of impregnated paper

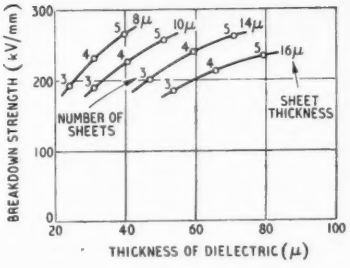

Fig. 6

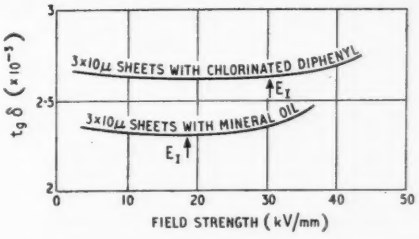

Fig. 7

On the other hand without any reduction in electrode spacing, an economy in foil area can still be achieved by using impregnants of higher permittivity. By use of equations (i) and (ii) the electrode area for a given capacitance and spacing as a function of permittivity of impregnant and of paper density is expressed by:—

$$4\pi C_o d_o \left(\frac{\rho_e \epsilon^1_p + \rho_o \epsilon^1_1 - \rho_o \epsilon^1_p}{\rho_e \epsilon^1_p \epsilon^1_1} \right) \quad .. \quad (xix)$$

With a 0·1 μF 500 V capacitor working at a stress of 12 V/micron, the following expression for electrode area is obtained:—

$$\left[475 + \frac{1580}{\epsilon^1_1}\right] \text{sq cm} \quad .. \quad .. \quad (xx)$$

It is thus apparent that even without closer spacing, economy in foil, paper and dielectric volume can be achieved by increase of impregnant permittivity.

Comparative Dielectric Properties

In Figs. 3 and 4 will be seen the permittivities of capacitor mineral oil and pentachlorodiphenyl respectively. Characteristics for a range of chlorinated diphenyls were reported in the previous article,[2] and pentachlorodiphenyl is one which is commonly used as an impregnant. It is seen that at 20 deg C the permittivity of the chlorinated diphenyl at 50 c/s is about 5 compared with a value of 2·3 for mineral oil. Breakdown strengths were also reported in the previous paper, and the table shows the values obtained

BREAKDOWN VOLTAGES OF CAPACITOR IMPREGNANTS

Pentachlorodiphenyl		Mineral Oil	
Temp. deg C	b.d.v. kV	Temp. deg C	b.d.v. kV
30	>64	20	68
40	73	42	53
75	72	58	45
100	>71	78	62
		103	62

In these tests the following commercially available materials were examined:—Pentachlorodiphenyl, Aroclor 1254; mineral oil, commercially available capacitor oil.

over a temperature range with half-inch sphere electrodes and with a spacing of 3 mm. These results show a scatter, and insufficient measurements have been made to give reliable mean values, but, if anything, the pentachlorodiphenyl has a higher breakdown strength than mineral oil, with a mean value of 24 kV/mm as compared with 20 kV/mm over the temperature range tested. It is probable that these b.d.s. values will actually be higher in a capacitor, but a common value of 20 kV/mm will be assumed here in order to compare permittivity effects.

By applying these values to Fig. 2, it is found that dielectric volume can be reduced to one-third of its previous value by substituting pentachlorodiphenyl for mineral oil. The area of the capacitor can also be reduced to a half of its previous value. Even without reducing the spacing between the electrodes, it will be observed from equation (xx) that a 33 per cent reduction in foil area can be achieved.

The increase in composite dielectric permittivity that can be achieved by substitution of pentachlorodiphenyl for mineral oil depends on what fraction of the bulk volume of the paper is occupied by the impregnant. On the basis of the layer theory of impregnation it is possible to graph permittivity of the two-component system as a function of paper density. This has been done in Fig. 5, the calculations being made from equations (i) and (iii). It is apparent that higher permittivities are achieved by use of paper of high density. This graph affords a ready means of finding what increase of permittivity can be attained with a given paper by changing from mineral oil to chlorinated diphenyl.

Superiority of Chlorinated Diphenyl Paper

Measurements on impregnated paper have shown that the increases of permittivity predicted in the last paragraph do in fact occur, provided the windings are constructed at the correct tensions so as to leave no gaps between the sheets without crushing them. For example, Bornitz[7] has found increases of 30 to 40 per cent in the permittivities of impregnated papers by changing from mineral oil to pentachlorodiphenyl.

That the combined effect of these two properties of permittivity and breakdown strength leads to a higher resultant breakdown strength in the two components system of paper and chlorinated diphenyl has been demonstrated by Guthmann.[8] Fig. 6 shows his results of applying short time a.c. voltage to pentachlorodiphenyl impregnated papers by the VDE test until breakdown occurred. He also examined the effect on power factor of applying high voltages "non-destructively" to impregnated papers. These results, in Fig. 7, show that the graph of power factor/field strength passes through a minimum. The increase at higher stress is due to minor breakdowns in the dielectric leading to the production of ions which give rise to power factor effects. If the capacitor operates above this voltage its life will be short. It is clear that this potential gradient, known as ionization field strength, is much higher for the chlorinated diphenyl than for mineral oil. This applies for all thicknesses of dielectric as Fig. 8 shows. It is interesting to note that if the data we have previously reported for the two impregnants is inserted in the expression for maximum voltage stress (xvii) assuming a paper density of 1·2, values are obtained which are almost exactly the same as Guthmann found experimentally for ionization field strengths for large thicknesses of dielectric. This is to a certain extent fortuitous, since it is hardly likely the b.d.s. of the fluids were the same in both investigations, but nevertheless this gives some evidence that the above theory is correct. The effect of high voltage on life has been graphically described by Marbury[9] in Fig. 9, and it is seen that below a certain stress, which is again the ionization field strength, life increases very considerably with these capacitors. Although a voltage rating considerably below this critical

voltage must be adopted to allow for overvoltage, manufacturing variation, and rating tolerances, nevertheless higher stresses can be permitted with chlorinated diphenyl capacitors.

Low Temperatures

It will be observed that there occurs a drop in permittivity with the chlorinated diphenyl depending on temperature and frequency. At the temperature at which this occurs the fluid freezes, and hence the free dipoles, which are responsible for the high permittivity, can no longer respond to the a.c. field. All that remains is the electronic component of permittivity giving values very similar to those of mineral oil. This leads to a drop in the capacitance of chlorinated diphenyl capacitors as Fig. 10 shows[10]. Nevertheless, for indoor operation and mild climates, the pentachlorodiphenyl capacitor is adequate. If lower temperatures are encountered trichlorodiphenyl is more suitable as Fig. 11 shows, but it is also possible to blend pentachlorodiphenyl with trichlorobenzene to reduce the pour point.

In this connection it is important to bear in mind the power factor characteristic. This is shown for pentachlorodiphenyl in Fig. 12 and was measured simultaneously with the permittivity by Schering bridge. It is seen that a prominent peak occurs at the pour point of the fluid. This causes heat dissipation, and the capacitor warms up and thus regains its full capacitance value. Marbury[9] has examined the time required to recover the full kVAr capacity if a pentachlorodiphenyl capacitor is disconnected, cooled to — 60 deg F and then brought into circuit. This is shown in Fig. 13. The same author has found that cooling the unit to only 0 deg F leads to the recovery of full capacitance in a few seconds when put on load. Furthermore under continuous operation this power factor peak prevents any fall in capacitance down to even the lowest temperatures, as shown in Fig. 10. At the same time power factor remains at a low value under these conditions as can be seen.

Capacitor Power Factor

Examination of the upper temperature region of the power factor curves in Fig. 12 reveals that the power factor of the chlorinated diphenyl is higher than that of mineral oil which is shown in Fig. 14. Coquillon has shown that in this region these values are inversely proportional to the viscosity of the fluid.[11] This indicates a flow of charged particles through the fluid due to the presence of ionic impurity. Such impurity should always be removed as far as possible in the process of manufacture of capacitors, and Fuller's earth is normally used.

The existence of ions will raise the power factor of the finished capacitor. However, the ions are dissolved in the dielectric, which is itself contained in small pores within the paper. To contribute to power factor these ions must move in the applied field, converting its potential energy into thermal energy in the dielectric. If, however, the ions are prevented from moving by a barrier of some sort, they will make no contribution to power factor. If the pore size is small enough, the applied field will carry

Fig. 8.—Ionization field strength as a function of dielectric thickness

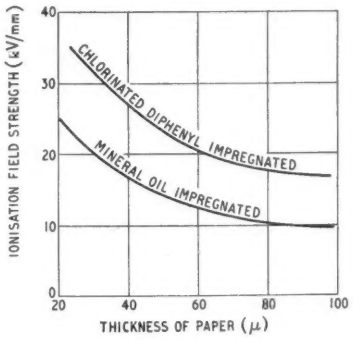

Fig 8

Fig. 9.—Life of a 2,300 V 10 kVAr capacitor at various applied voltages

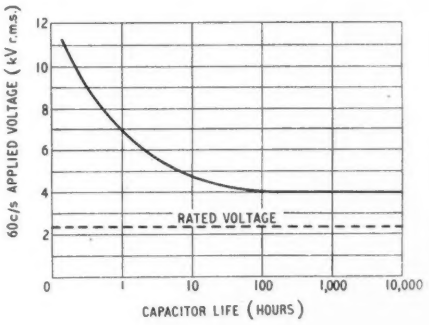

Fig 9

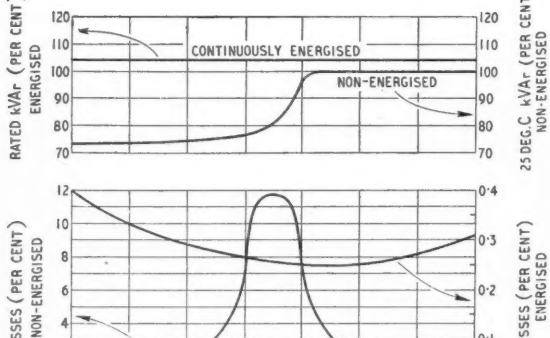

Fig. 10.—Behaviour of a chlorinated diphenyl capacitor at various temperatures on and off load

the ion to the wall of the pore in a small fraction of the half cycle and for the greater part of the half period the ion will be unable to move. Therefore the power factor should be reduced in this way. Garton[12] has shown, and Dakin and Craig have confirmed,[13] that this is actually the case for the field used in capacitors, and therefore paper of small pore size is best employed to reduce the power factor contribution from the impregnant. The higher power factor of the chlorinated diphenyl at higher temperatures is not therefore as important as at first it might appear.

However, with the series arrangement of the impregnant that has previously been described, it is apparent that the power factor of the complete capacitor will anyway be higher with an impregnant of higher permittivity. This is because a higher stress is applied across the paper layers, and the ions and resonating dipoles in the paper hence absorb more energy. A formula has been evolved on this basis by Race, Hemphill and Endicott[5]:—

$$\frac{\theta_p \epsilon^1_1 \phi_p + \theta_1 \epsilon^1_p \phi_1}{\theta_p \epsilon^1_1 + \theta_1 \epsilon^1_p}$$

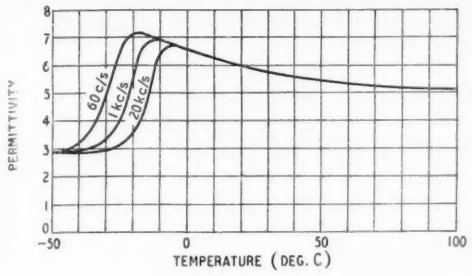

Fig. 11
Permittivity of trichlorodiphenyl (Aroclor 1242)

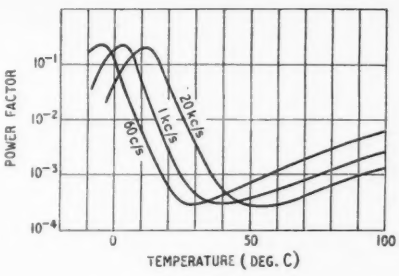

Fig. 12
Power factor of pentachlorodiphenyl (Aroclor 1254)

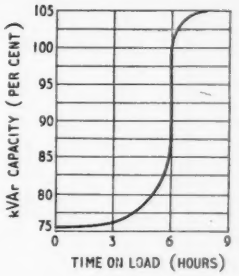

Fig. 13
Rate of regaining capacitance when a pentachlorodiphenyl capacitor at — 60 deg C is put on load

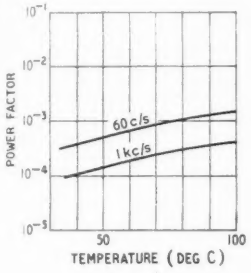

Fig. 14
Power factor of mineral oil

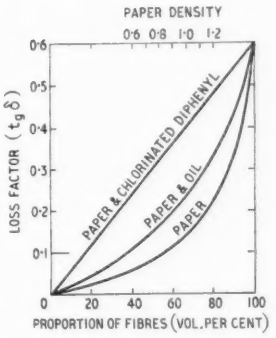

Fig. 15
Effect of impregnation on the loss factor of papers of different densities

Where θ refers to volume fraction
ϕ refers to power factor
ϵ^1 refers to permittivity.

Inferiors 1 and p refer to impregnant and paper fibre respectively.

These authors have examined this relation experimentally, finding it essentially correct and using it to predict the effect a paper will have on the power factor of a finished capacitor. Coquillon has drawn a theoretical curve on this basis showing the relation between power factor of the capacitor and volume fraction of paper present.[14] This is reproduced in Fig. 15. It is apparent that the power factor of a chlorinated diphenyl capacitor will be inevitably higher than if mineral oil is used and the way to reduce capacitor power factor lies in the direction of improving the paper quality.

Size Economies Achieved in Practice

It has been shown that ideally a reduction in dielectric volume of two-thirds and in electrode area of one-half is possible in changing from mineral oil impregnant to chlorinated diphenyl. This, it has already been pointed out, cannot be achieved in practice owing to allowances for surge overvoltage and internal heating. There is also a considerable " dead space " in the can that cannot be reduced to the same degree. In America, nevertheless, the size of finished power factor correction capacitors have been reduced by more than 50 per cent by using pentachlorodiphenyl.[15] In the United Kingdom, Robinson and Dyer[16] have reported that 40 per cent economies in size have been achieved with capacitors for fluorescent lighting units. Although the synthetic fluid is more expensive to produce than the naturally derived mineral oil, the increased price of impregnant is more than offset by the savings in paper and foil. What is even more important from the commercial point of view is the greater productivity which can be achieved by using chlorinated diphenyl: it is possible to produce 50 per cent more units of a given rating with the same size of plant and with very little extra labour. This is an achievement which cannot be ignored.

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I.E.S. Liverpool Centre

" Illumination without engineering and technical background would be a disastrous failure," said Sir Herbert W. Barber, J.P., director of Johnson & Phillips, Ltd., at the recently held annual luncheon of the Liverpool Centre of the Illuminating Engineering Society. The aim of all, he said, should be to obtain the best possible lighting with modern fittings, designed by scientific calculation, to enable the hours of darkness to become as near as possible to daylight. Shopkeepers who kept their windows illuminated after closing hours not only attracted customers but also helped to make the streets or roads safer for pedestrians.

Lighting costs should be a national responsibility and grants to local authorities be more liberal for thoroughfares other than those classed as trunk roads. Assistance was at present limited to trunk roads, yet in many places most of the traffic using a road might be through traffic and local ratepayers had to bear the cost of lighting. There should be greater co-operation between the lighting engineer and the highway engineer, so that road surface should be in harmony with the lighting of the particular road. Revolutionary changes through the development of atomic energy and Government policy for new power stations might require a new technique of industrial control.

Mr. E. C. Lennox, M.I.E.E., president of the I.E.S., spoke of Liverpool's enormous problems in the sphere of lighting and of the economy that could be achieved in production and the quick turn-round of ships by having better lighting standards.

Selling Electricity

Views Expressed at the E.D.A. Annual Luncheon

AT the British Electrical Development Association's annual luncheon at the Savoy Hotel, London, on 10th May (briefly mentioned in our last week's issue), Lord Jowitt, proposing the toast "Electrical Development," said that the development of the electrical industry had been a success story, and it was now one of the largest, if not the largest, exporters of manufactured goods.

Electricity supply revenue had increased from £18 million in 1919 to £326 million in 1954, and he thought that in 1955 it would be nearly £350 million; in the same period the number of consumers had risen from 1 million to 14½ million, and the consumption per head of population from 72 to 1,104 kWh a year. Even since 1947, revenue had increased from £183 million to £326 million, consumers by 3 million and consumption per head of population by nearly 60 per cent.

Rural electrification was one of the most important features of the industry, and the number of farms connected since 1947 had increased from 78,000 to 152,000. Only with the aid of electricity could we achieve a vitally necessary increase in agricultural production. Whereas in 1939 14 per cent of the world's food supply was available

Some of the People at the E.D.A. Annual Luncheon

1.—Mr. W. S. Lewis, Sir John Hacking, Mrs. Steward, Mr. S. F. Steward, Viscount Chandos and Mr. H. J. Randall. **2.**—*Mr. J. S. Pickles, Sir Charles Cunningham and Mr. A. G. F. Farquhar.* **3.**—*Lt.-Cdr. L. W. Joynson-Hicks replying for the guests.* **4.**—*Sir Henry Self, Lt.-Cdr. L. W. Joynson-Hicks and Mr. S. F. Steward.* **5.**—*Lord Jowitt proposing the toast, "Electrical Development."* **6.**—*Mr. V. A. Pask, Mr. C. R. King, the Dowager Lady Swaythling and Mrs. King.* **7.**—*Mr. V. W. Dale, Sir Lawrence Bragg and Sir John Hacking*

for sale, to-day the figure was only 4 per cent; the world population was increasing, and he said there was no guarantee that in 20 years' time even that 4 per cent would be available.

In spite of these achievements saturation point was further away to-day than in 1919, and the time must come when conventional fuels would be in short supply. It was estimated that electricity consumption would increase three and a half times in the next 20 years, and to cope with this the Government had announced a ten-year nuclear power programme on a scale larger than that of any other country, although even this programme would provide only an extra 2 million kW. Great Britain must maintain her lead in the development of nuclear power for peaceful purposes, for thus and thus only would the lives of our people at work and at leisure be brightened and made more fruitful by electricity, at long last cheap and abundant.

Sir John Hacking, the president of E.D.A., replying and proposing the toast of the guests, said the growth of the demand for energy in all its forms was one of the most striking features of modern civilization, and measured by the standard of comfort electrical energy had been responsible for a very substantial portion of that growth, to a continuation and even acceleration of which we could look forward.

To illustrate the changing pattern due to overcoming plant shortages, Sir John said that in the year preceding vesting date the average efficiency of generation was 20·87 per cent; in the following three years it rose slowly, at an average annual rate of 0·22 per cent; in the next three years, however, the average annual rate of increase was 0·62 per cent, and in the last of those years 0·68 per cent, the last published figure being 23·4 per cent for the year ended 31st March, 1954, and he thought that by 1960 they could confidently expect a figure substantially in excess of the 26 per cent forecast by the B.E.A. two or three years ago.

In America the net thermal efficiency was 28 per cent, and some of the new plant at present under construction in this country should achieve figures approaching that. It was probable that by 1958 the total coal consumption per kWh sold would be at least 10 per cent less than in 1954, and 20 per cent less than in 1948, the total running costs being less by a like amount. On the other hand, in 1954 approximately one-third of the total capacity was commissioned after 1947 at the higher prices then ruling, but by 1958 this would be increased to one-half, and the plant charges per kW installed would probably rise by at least 20 per cent above 1954, and he thought that by 1958 fixed costs per kWh would rise considerably and the running costs fall appreciably. The national load factor, based on potential demand, had been falling, he said, and in 1953-54 was below 44 per cent, the American figures generally being 60 per cent and upwards. The importance of improving load factor to spread fixed charges over a larger number of units was fully appreciated by the industry, and it would become considerably more important during the next few years.

Obviously, a 44-hour week in industry could not produce an annual load factor better than 26 per cent, and even if industry worked at a dead level rate over all working hours, it must be operating at substantially lower load factors. Although industry was limited at the present plant investment level by the number of men available, the same amount of work could be done with a smaller plant investment by working longer hours. With the future application of electronically controlled devices it was to be expected that the capital cost of the plant and its associated control would increase, but there would be a large reduction in the amount and cost of the required labour, which might result in a substantial increase in shift work, and consequently in the load factor of industrial supply.

Undoubtedly, the future was bright for the prospects of electrical development, but it was necessary to continue to educate and encourage potential users so that future benefits accrued to the nation as a whole. The work of E.D.A. in educational activity, in industry, agriculture and the home was very high. Farmers must be educated to use electricity, not only for home comforts but for mechanical purposes on their farms, and he suggested that in farming areas electricity salesmen should be men with personal experience of agriculture.

Lt.-Comdr. the Hon. L. W. Joynson-Hicks, Parliamentary Secretary to the Ministry of Fuel and Power, replying for the guests, begged the industry to push its exports as hard as it could, taking the present remarkable standard as a starting point. Referring to the sale of appliances in this country, he said that between 1951 and 1954 sales of refrigerators had increased by 13 per cent, cookers by 27 per cent, immersion heaters by 80 per cent, and washing machines by 93 per cent.

In our last issue we omitted to mention that the new vice-chairman of the E.D.A. Council is Mr. D. Bellamy, O.B.E., chairman of the Yorkshire Electricity Board.

Electrical Development in Venezuela

ONE result of the economic progress of Venezuela in recent times has been a marked increase in the use of electricity, states Mr. R. S. Scrivener, First Secretary (Commercial) to H.M. Embassy, Caracas, in his report on the economic and commercial conditions in Venezuela (H.M. Stationery Office, 3s 6d net). In 1948 electricity production (excluding electricity produced by industry for its own use) was 345 million kWh. In 1953 the total was 841 million kWh and in the first quarter of 1954 generation had risen to an average of 75 million kWh per month. As a result of studies made by the Venezuelan Development Corporation it is estimated that the demand will increase to 930 million kWh in the current year and 1,750 million kWh in 1970, by which time the consumption per head will be about 220 kWh per annum.

For some years past the Venezuelan Development Corporation has been the principal agent in carrying out the electrification programme. During 1953-54 it invested some 36 million bolivars (£1=9·30 bolivars) in additions to generatng plant, part of a wide plan which envisages a capital exependiture of between Bs 200 and Bs 300 million in the next few years. The future of electricity in Venezuela will be fundamentally affected by the decision to go ahead with the installation of a hydro-electric plant on the River Caroni. The initial capacity of the generating station is scheduled at 150,000 kW but the design will allow for subsequent expansion to double this figure. The scheme is not under the auspices of the Development Corporation but under the direct charge of the Ministry of Development.

Mr. Scrivener states that Venezuela is a traditional market for United States domestic machinery and apparatus. The majority of domestic appliances imported during 1953 were of United States origin, and if the United Kingdom is to compete it will be necessary for such appliances to be modelled upon United States standards.

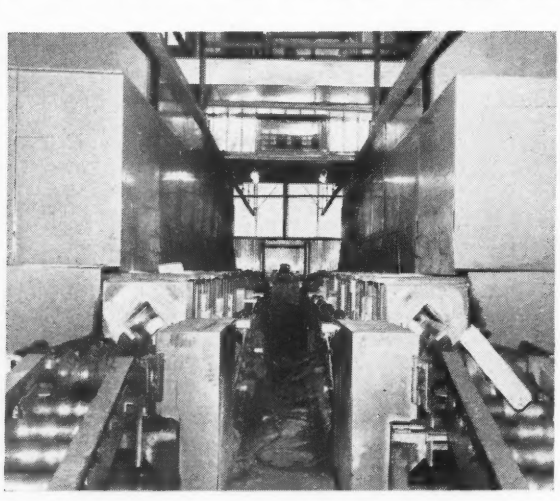
The field for generating plant has a promising future. To date the majority of the large contracts have gone to the United States, but there is now much greater interest, not only for reasons of price, in European equipment and there is no reason why the United Kingdom should not have at least as great a share in the market as other European countries.

Induction Heating in Steel Rolling

Convenience and Economy

PROBABLY for the first time in the world, ingots are now being heated by electric induction at the Vancouver Rolling Mills plant of Western Canada Steel, Ltd., in Vancouver, Canada. Using available figures of comparative costs of operation in Western Canada of rotary hearth furnaces, pusher furnaces and batch-type furnaces, the new dual frequency, twin-tube induction furnace shows a considerable saving over conventional heating methods. In addition, although no de-scaling equipment is used, the rolled products are clean in appearance, and comparatively free from scale. This attractive feature, which carried considerable weight in making the decision to swing to induction heating, gave the possibility of reducing normal scale loss experienced in standard type furnaces (between 3 and 5 per cent). It was calculated that this alone would yield a saving of 80 cents per ton per 1 per cent decrease. In practice, an average scale loss of less than 2 per cent has been realized.

The actual heating takes place inside a tube, or coil tunnel, through which the ingots are pushed in a continuous stream end to end. Since the heat is generated within the ingot, it is possible to keep the furnace structure, including the outside surface of this tunnel, quite cool. To keep the overall length of the unit down, it was designed with two identical parallel tunnels. This arrangement also provides some increase in flexibility, since either side may be operated independently. Fork-lift trucks are used to bring the ingots from stock piles in the yard, and to place them on a table fitted with " walking beams " which spread out the bundles of ingots and advance them to another table fitted with flat rubber conveyor belts which carry the ingots forward to the feeders. More automatic handling equipment carries the ingots from this point and deposits them as required, one at a time, in the feed trough. Hydraulic rams push the ingots from the feed troughs into the heating tunnel where the line of ingots is continuous, so that, as one ingot is being pushed into the feed end, a hot ingot is emerging from the discharge end. Interlocks keep the two lines in step, so that ingots are fed to the mill at regular intervals. The heating tunnels are built in two sections, the first using 60 c/s and the second 540 c/s a.c.



Twin induction heating furnaces at Vancouver rolling mills

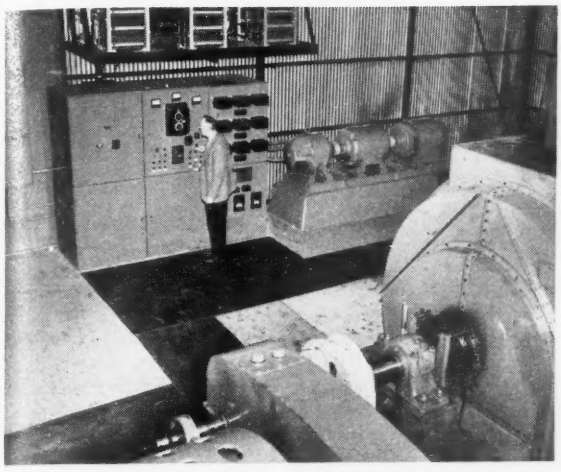
An operator's " pulpit " is arranged above the two lines, so that he has a good view of both ends of the furnace, and also a clear view of the mills. The control panel includes radiomatic pyrometers for indicating the temperature of the steel, situated at the end of the 60-cycle section, the centre of the 540-cycle section, and at the discharge point. The operator also has control of the rate of feed and power input, as well as on/off controls for all parts of the installation. In addition he has control of a power-driven roller conveyor, which extends from the furnace to the mill, and a gate provided in this conveyor, which allows him to direct ingots to the mill, or to set them aside. Meters indicate current, voltages and power in the various circuits.

Basically, a load of 7,000 kW is involved, half being at 540 cycles and half at 60 cycles. The 540-cycle energy is supplied at 400 V, and the 60-cycle energy at 550 V. To obtain the high frequency supply a 3,500 kVA unity power factor, 720 r.p.m., 540-cycle alternator, driven by a 4,000 V synchronous motor, is used and provides opportunity for power factor correction of the remainder of the rolling mill induction motor load. It was found in service that the high frequency generator was able to operate substantially in excess of 400 V, provided the power factor was maintained at a proper level, and as the higher operating voltage appears desirable and temperature rise does not limit the current output, the 540-cycle alternator is actually used at a considerable excess capacity above its rating. Power is taken from the 60 kV system of the British Columbia Electric Co., Ltd., via three 3,000 kVA water-cooled transformers for stepping down from 60 kV to 4 kV. The 60-cycle supply is obtained from a 4,000 kVA 3-phase transformer with off-load tap changing and stepping down to 550 V.

The motor driving the 540-cycle generator is started by means of an auxiliary slip-ring motor, and synchronized by an automatic synchronizer under push-button control. An air clutch disconnects the slip-ring motor after synchronization is completed.

Power factor correction of the induction heating coils is a major element of the installation, and capacitors are connected in batches to each coil group of both frequencies. The correction required varies in the different coil groups with the temperature of the billets passing through the heating coils. Initially the inductance was higher at the cold section of the furnace, and adjustments were made from experience to secure the optimum power factor conditions. The capacitors for the 540-cycle coils are water-cooled, those for the 60-cycle coils not being cooled at all. The average power factor throughout is better than 0·9 and approaches unity under most conditions. It is, however, subject to variations depending upon the sizes of ingots fed through the coils.

In order to control the heat input to the high frequency coils, a motor operated field rheostat permits the variation of the 540-cycle alternator voltage. Input power is measured by wattmeters and watthour meters, and these



Motor generator room for the 540-cycle heating supply

have established a power consumption on the largest ingots of 300 kWh/ton, or better, including all losses. The rate of flow of the larger ingots varies from twenty to twenty-five tons per hour. With smaller ingots, the average consumption is higher, and the rate of flow somewhat less.

One of the most striking features of the new operation is its speed. The total heating time ranges from 3·6 min for the smallest ingots to 8·4 min for the largest. This compares with 45 min for similar large ingots in an oil-fired furnace.

The furnace operates with a total number of four men per shift, and higher production rates than at present achieved will not require an increase. The furnace crews' working conditions have improved immeasurably. They are at no time subjected to heat, and can work in perfect safety and comfort throughout the operation.

The coils present the most serious maintenance problem. They are insulated with glass tape and silicon varnish, and cast in a moulded refractory of high density and strength which prevents the vibration of the coil from breaking down its insulation. In the beginning the coils were constructed with 310 stainless steel liners. The insulation packed between the coil and the liner broke down after eight or nine shifts and it was found that the severe vibration of the ingot resulted in the liner abrading the insulation, until a short circuit between turns occurred. These stainless liners have in the main been discarded, and replaced by high silicon ceramic liners, these liners being bonded to the coil and held immobile by the moulded refractory.

The unit was built by the General Engineering Co., Ltd., Toronto. Design commenced in November, 1953, and the unit went into full production the following July. By March of 1955 (8 months later) it had heated over 30,000 tons of ingots. The approximate annual finishing capacity of the mill is 70,000 tons and the new installation is estimated to have increased production by 30 per cent with a fuel saving of about $1 per ton of steel. The cost of the heating installation was $500,000.

News from Australia

From a Correspondent

RUMOURS that still heavier import restrictions are likely in July are based largely on wishful thinking, according to Sir John Allison, president of the Melbourne Chamber of Commerce. Sir John, who is also a member of the Commonwealth Consultative Committee on Imports, says it is becoming more apparent that the cuts announced in March were more severe than were warranted by the circumstances. "Importers throughout Australia, contrary to suggestions, do not believe that import licensing is here to stay," he says, "but rather that it will have to be lessened in the near future and finally abolished. The latest import cuts will result in a tendency towards inflation, and this process will grow unless urgent attention is given to the question of reducing costs of production and boosting exports considerably."

The National Bank, through a spokesman, says that if a chronic weakness in Australia's overseas balances has developed, the fundamental issues involved will have to be faced, "as permanent import restrictions are indeed a poor prospect."

The drain on the Commonwealth Bank's overseas holdings of gold and balances, though amounting to £10 million in the fortnight to 13th April, has been going on at a slower rate, a trade surplus of £4,700,000 in March, the first monthly surplus since December, and the third of the current trade year, helping to stem the flow.

In less than nine years the proportion of New South Wales farmers connected to the electricity supply has increased from 22 to 55 per cent, giving that State the highest percentage of electrified farms of all the mainland States. Between August, 1946, and December, 1954, about 15,400 miles of new rural lines were erected to serve 24,000 farms and 18,000 other rural consumers, capital expenditure on this work having reached almost £9½ million. "At the present rate of progress," says the secretary of the Local Government Association, "70 per cent of the State's farms should be supplied with electricity by 1960."

During the first quarter of 1955 retail sales of electrical goods in Australia were maintained at higher levels than those of the same period of the previous year. But authorities in the trade point out that the spectacular growth in the Australian production of electrical goods over the past few years has levelled off, and that sections of the industry may face difficulties as production finds its level in relation to a steadier demand.

Sales of radio sets for the first quarter of this year were above the level of the corresponding period of 1954, with production and sales tending towards the smaller types. Production of radiograms in January was 3,680, compared with the 4,350 of January, 1954.

Sales of washing machines are expected to keep fairly stable "providing the selling pressure is maintained," but in the refrigerator field there are signs of a recession, with a sharp drop in output.

Many retailers have been selling electrical appliances on extremely low deposits and very small weekly payments, but legislation is being introduced in several States to prohibit hire-purchase sales with an initial deposit of less than 10 per cent.

WORLD ELECTRICAL MARKETS

Openings in Colombia

From a Correspondent in Bogotá

AS might be expected of a country whose main geographical features are three mountain ranges up to 17,000ft high, with two major rivers between them and substantial tributaries flowing down their slopes every few score miles, Colombia has great potentialities in the field of hydro-electricity. There are also several coalfields and a surplus of locally produced fuel oil capable of supporting economic large-scale steam generation.

Nevertheless at the end of 1953 installed capacity in public service generating stations totalled no more than 338 MW, of which two-thirds was in hydro-electric plants, while private industry had installed at least 50 MW of capacity for its own use and in some cases was helping out the public supply.

With the exception of Medellín, Barranquilla, and Manizales, no major centre in Colombia can claim to be within reach of supplying its needs. Every city and municipality has its plans, of course, and the natural resources to give them effect exist, but difficulties of terrain and shortages of finance, engineers, and constructional firms have limited actual development and even future projects, at least those under active study, to a scale still insufficient to catch up with a demand still increasing in step with a rising standard of living. Industrialists are in many cases compelled to continue installing their own generating plant.

The general situation may thus be summarized as one of opportunities primarily for suppliers of generating and distribution equipment and of industrial machinery; domestic appliances are also in increasing demand except for heating and other purposes requiring heavy current consumption, the installation of which is severely limited by almost all supply authorities; nor can they be expected to relax these restrictions for many years, since the industrial load is likely to increase rapidly.

Electricity in Principal Cities

Most of the power generation capacity at present serves the larger cities. Medellín, as the centre of the main industrial area, had at the end of 1953 a total of 101·5 MW, Bogotá 66·2 MW, Barranquilla 29·6 MW, Manizales 25·6 MW, and Cali 12·9 MW. Most other departmental capitals and larger towns have plants of a few thousand kilowatts. Cali's lack of power is due to prolonged delays in bringing into service the 24 MW Anchicayá hydro-plant, which is being constructed under extremely difficult conditions on the high-rainfall Pacific slopes of the western Cordillera; the Colombian Electricity Company, a subsidiary of the American Foreign Power Company, from its Palmira plant, and a local cement works from its private supply, are both selling Cali power.

Further installation by 1957 of 12 MW at Anchicayá, and a 20 MW coal-fired plant at Yumbo by 1958 will barely bring Cali abreast of Bogotá's 1953 figure, while the prospects of an additional 32 MW at those sites together with 50 MW and eventually 200 MW from the Calima river are more distant still; an unsatisfactory position since the city has been chosen, on account of its many other advantages, as the site for many new and rapidly expanding industries.

Medellín's municipal enterprise and the Colombian Electricity Co. at Barranquilla are keeping abreast of domestic and industrial requirements, with the advantage of a warm climate which involves little or no potential domestic heating load; they are also selling to neighbouring municipalities and have development plans for 65 MW and 45 MW respectively in the next five years which should maintain the position. In the Department of Caldas, Manizales and other substantial towns are at present adequately supplied from the Departmental hydro-plant. Cartagena's new municipal plant of 10 MW which has been delivered from Germany and will soon be installed will enable that city also to supply its hinterland.

Bogotá's municipal power company however, even with its additional 75 MW capacity now under construction, and other projects well advanced, has a potential industrial and cold-climate domestic demand which is likely to keep ahead of supplies for some time, while any rural electrification in the surrounding and comparatively heavily populated department of Cundinamarca, or any projects such as the proposed metropolitan railway, will have to find their own new sources of power.

Electrical Development Institute

Of the developments mentioned above, those for Cali and Cartagena have been promoted and partly financed by the Electrical Development Institute, a semi-Governmental body which in addition to such activities has now been entrusted by the Government with the responsibility for co-ordination and planning over the whole field of electrical generation and distribution in Colombia. The Institute has engaged as consultants to draw up a national plan Gibbs & Hill, of New York, and Electricité de France, who have four and three engineers respectively working on it in Colombia together with seven engineers of the Institute. The report of the manager of the Institute, dated June, 1954, and published last November, is a mine of well-presented information on all these aspects of its work.

Developments outside the Cali and Cartagena areas in which the Institute is interested, and which should come into production early this year, total 23 MW, while 85 MW more is hoped for by the end of 1957. These schemes include the first approach to a grid system in the area of the national steelworks at Belencito. The installed steam generating capacity at this works is 25 MW of which 10 MW is surplus until the steelworks are expanded. Orders are being placed for a new 25 MW steam plant at Paipa and a 66 kV, 37 km transmission line linking Paipa and Belencito and feeding in addition Duitama and Sogamoso, where several steel-using industries are already being established and more are planned.

The national plan's preliminary outline, drawn up by the Institute and now being elaborated by the consultants, envisages three main areas which in the first stage would each be developed into its own interconnected system and in the more distant future would be connected into a

national grid. The first main area is on the Atlantic coast, including Barranquilla, Cartagena, and Santa Marta; the second, running from Medellín through Manizales and Cali to the south, is more or less co-terminous with the valley of the Cauca river, for the upper part of which, round Cali, the Government has created an independent development authority modelled on the Tennessee Valley Authority; the third, centred on Bogotá, embraces the upper Magdalena valley and the highland valleys of the eastern Cordillera as far north as Cúcuta.

The Cauca Valley Authority has engaged as consultants a consortium of Gibbs & Hill and Knappen Tibbetts, Abbott & McCarthy (both New York firms) and the latter's Colombian associates, Olarte Ospinas Arias & Payán. The contract specifically provides that any plans drawn up by the consultants shall be such as to permit international competition for the supply of equipment, and that none of them can engage in any construction work.

In addition to the existing installations and projects already mentioned, at least half-a-dozen major new hydro-electric plants are in early stages of consideration to complete these systems. Until the national grid is extended to the Atlantic coast, however, that area's requirements will have to be generated locally using steam raised by oil, of which the Magdalena river and the Andean pipeline can carry plentiful supplies from the inland oilfields.

The manufacture of electrical equipment in Colombia is very limited, and no electrical firm has a production large enough to appear in the statistics. As regards domestic goods, the largest factory is one making incandescent lamp bulbs, but although these are heavily protected by a tariff the imported product sells well on its definite superiority. In 1952, 163 tons net was imported, valued c.i.f. at 1·5 million pesos.* Of these lamps 111 tons came from the United States, 19 from the Netherlands, and 16 from Germany.

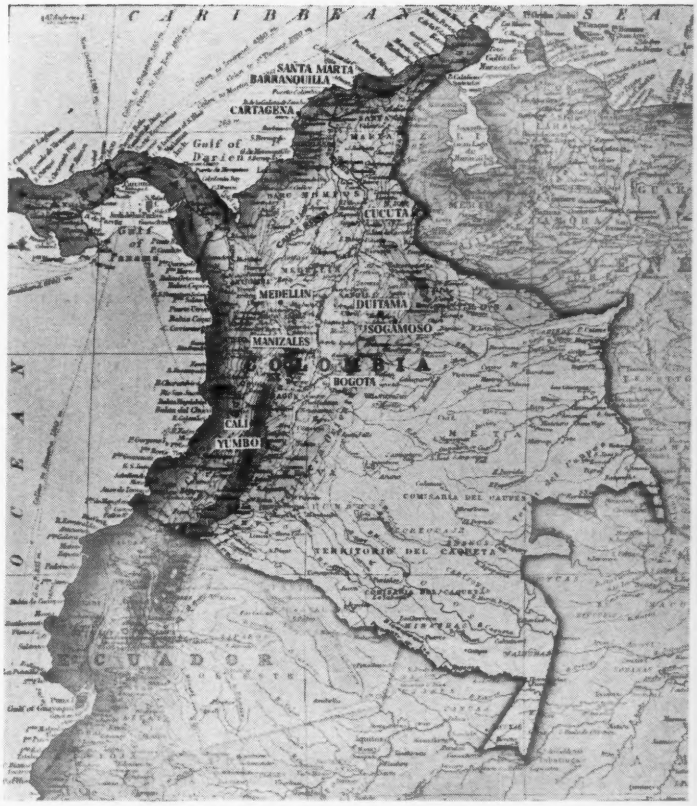
There is some local production or assembly of domestic appliances and accessories, including lamps, small cooking stoves, heaters, electric irons, electric blankets and radio receivers, but the principal supplies come from abroad, mainly the United States, with Germany as second supplier, except of electric irons for which the position is reversed. The Netherlands and, except for valves, the United Kingdom, supply substantial quantities of radio sets and parts, Sweden of cooking stoves, and the United Kingdom of irons.

There is no local production or assembly of domestic refrigerators, though most of the large United States firms have subsidiaries or agents who assemble industrial and commercial refrigeration and air conditioning installations from components which are imported, except ducting and other simple sheet work. The United States is again the principal exporter to Colombia, with Sweden supplying 10 per cent of the domestic refrigerators, and Germany and Switzerland between them 10 per cent of other refrigeration apparatus. The United States supplies 94 per cent, the United Kingdom 3½ per cent, and Canada 2·3 per cent of the domestic washing machines. The total imports of the above products in 1953 were as follows:—

Appliances	Metric tons	Thousand Pesos
Cooking stoves	254	1,232
Heating apparatus	225	1,264
Electric irons (number)	71,612	540
Radio receivers (number)	51,391	5,662
Domestic refrigerators	3,309	15,747
Domestic washing machines	547	2,540

There is local manufacture of dry batteries and accumulators, porcelain insulators, and small transformers, for

*£1 = 7 pesos (approx.)



Map showing sites of power schemes in Colombia

which Bogotá's unusual voltage of 150 provides a good market, while facilities exist for rewinding and overhauling electrical machinery. The nearest approach however to manufacture of electrical machinery is the assembly of small generating sets from imported engines and generators, which is carried on on a small scale in several of the main industrial centres. One factory assembles welding sets.

Essentially, however, Colombia's needs of electrical machinery and apparatus are still imported, at an increasing rate commensurate with industrial development. Total imports of electrical machinery and apparatus (including that mentioned above) in 1952 were 15,819 metric tons gross, valued at 72·5 million pesos, while in 1953 the corresponding figures were 22,760 tons and 87·4 million pesos. The principal constituents of the 1953 figures were:—

Class	Metric tons	Thousand Pesos
Dynamos and generators	4,256	10,250
Motors	1,829	6,190
Transformers	1,502	6,069
Rotary convertors	196	1,117
Dry batteries	1,155	2,326
Accumulators	1,295	3,094
Motor accessories	372	3,675
Meters	120	1,208
Cable and wire (lead or metal covered)	715	2,114
Cable and wire (rubber or similar)	2,117	6,423
Other cables	487	1,579
Lampholders, plugs, switches, etc.	352	2,140
Misc. distribution apparatus	772	5,420

The main suppliers were:—

Dynamos and generators.—France 81 per cent (probably an exceptional figure, destined for the National steelworks at Paz de Rio: in 1952 France supplied 50 per cent), United States 13 per cent, and the United Kingdom, Germany,

Netherlands, and Switzerland in that order 1 per cent or less.

Motors.—France 49 per cent (cf., as before, in 1952 15 per cent), United States 31 per cent, Switzerland 7 per cent, United Kingdom 5 per cent, Germany 2 per cent, and Sweden, Austria and Denmark each about 1 per cent.

Rotary convertors.—France 75 per cent, United States 15 per cent, Switzerland 6 per cent, United Kingdom 2 per cent, Germany and Sweden 1 per cent each.

Transformers.—United States 62 per cent, Switzerland 12 per cent, Belgium 10 per cent, France 5 per cent, Germany 4 per cent, Netherlands 3 per cent, United Kingdom 1 per cent.

Dry batteries.—United States 98 per cent, Denmark 1 per cent.

Accumulators.—United States 76 per cent, Canada 9 per cent, Sweden 6 per cent, Germany 5 per cent, United Kingdom 3 per cent.

Motor Accessories.—United States 38 per cent, United Kingdom 6 per cent, Germany 4 per cent.

Meters.—United States 20 per cent, Switzerland 17 per cent, Belgium and Canada 12 per cent each, United Kingdom 10 per cent, Germany 8 per cent.

Cable and wire (lead covered).—United States 42 per cent, United Kingdom 28 per cent, Sweden and Italy 10 per cent each, Canada 3 per cent, Germany 2 per cent, Netherlands and France 1 per cent each.

Cable and wire (rubber insulated).—United States and Italy 26 per cent each, Germany 25 per cent, Canada 6 per cent, France and United Kingdom 4 per cent each, Netherlands 2 per cent, Belgium and Luxembourg 1 per cent each.

Other cables and wire.—United States 54 per cent, Germany 19 per cent, Italy and Canada 8 per cent each, France 3 per cent, United Kingdom 2 per cent, Belgium and Chile 1 per cent each.

Lampholders, plugs, switches, etc.—United States 78 per cent, Germany and Japan 7 per cent, Mexico 3 per cent, Italy 2 per cent.

Miscellaneous distribution apparatus.—United States 76 per cent, United Kingdom and Germany 7 per cent, Switzerland 4 per cent, Netherlands 2 per cent.

Minor imports of electrical machinery and apparatus in 1953 (mostly from the United States) included 82 tons of static convertors valued at Ps.467,000; 24 tons of electro-mechanical tools valued at Ps.400,000; 49 tons of industrial electric furnaces valued at Ps.252,000; 166 tons of carbon and graphite parts valued at Ps.489,000; 242 tons of ceramic insulators valued at Ps.390,000; and 337·7 tons of conduit tubes and fittings valued at Ps.524,000.

Thus from the import figures as well as from the general picture of the market in Colombia given earlier in this article, there appears to be room in it for substantial effort by British exporters.

Load Building in Malaya

AN improvement both in the security position and in generating plant capacity in Malaya last year enabled the electricity supply authorities to turn their attention to encouraging load development and good progress has been made in this direction. Although the main consumer, the tin mining industry, was affected by a fall in the price of the metal there was a general increase in consumption in the Federation and the overall output of 841·5 million kWh (including 115 million generated by private mining installations) was some 10 per cent more than in 1952-53. Towards the end of the year a recovery in tin prices led to a higher rate of electricity consumption in that industry.

The chief public supply authority in the Federation is the Central Electricity Board, set up in 1949, of which Mr. F. P. Egerton, C.B.E., M.I.E.E., was appointed temporary chairman last year. Licences for public supplies are also held by the Perak River Hydro-Electric Power Co., Ltd., the Kinta Electrical Distribution Co., Ltd., and Huttenbachs, Ltd., and an electricity undertaking is operated by the municipality of George Town, Penang. The C.E.B., whose report for the year ended 31st August last has just been received, is responsible for about 40 per cent of the electricity distributed in the Federation (297 million kWh last year compared with 259 million in 1952-53). It operates two steam stations, at Connaught Bridge and Bungsar; two hydro-electric plants, Ulu Langat Upper and Lower; and 36 diesel stations. A 120,000 kW hydro-electric development is projected in the Cameron Highlands. Investigations in this area had been held up by the difficult security position but towards the end of the year it was possible to carry out preliminary surveys.

Referring to the first 40,000 kW section of the Connaught Bridge station, the C.E.B.'s report says that after minor defects had been remedied the station settled down to trouble-free running. The first of two additional 20,000 kW sets was due for commissioning a month or so ago.

In the remote areas the Board's engineers and those of the other authorities carried out the work of providing and maintaining supplies despite terrorist activities. Security lighting of villages on behalf of the Government was virtually completed and efforts were made, with some success, to obtain domestic load in these villages. Except in the case of a few of the larger villages, however, it is thought unlikely that it will be possible to maintain these supplies on an economic basis when the need for security lighting has passed.

Good progress was made last year in selling appliances under the new hire-purchase scheme in which the Board has so far invested nearly $(Straits)1 million. Successful exhibitions were held at Johore Bahru and Kajang (near Kuala Lumpur). A domestic block tariff introduced in 1952-53 materially helped in the development of this type of load and an interim variable block industrial tariff substantially benefited consumers with high load factors.

The number of the Board's consumers at 31st August last was 80,355 against 66,368 a year before. The increase of 13,987 compares with 6,842 in the previous year. An analysis of sales shows that consumption by the mining industry was 90·7 million kWh—about the same as in 1952-53—but other industrial power supplies rose by 42 per cent to 68·9 million kWh; domestic light and power supplies by 28 per cent to 46 million kWh; and other lighting supplies by 6 per cent to 35·5 million kWh.

A mission from the International Bank of Reconstruction and Development surveyed the economic outlook in the Federation and the electric power section of the mission spent considerable time studying the public supply undertakings with a view to expansion over the next decade. The report of the mission is expected to be published by the middle of this year.

The Board's accounts show a total revenue of $25·5 million (against $23·3 million). Gross revenue expenditure amounted to $20·9 million ($19 million), leaving a balance of $4·7 million ($4·2 million) of which a dividend of 4 per cent on the ordinary stock absorbed $1·5 million.

Capital expenditure during the year amounted to $20 million. Apart from work on the second stage of the Connaught Bridge station, major projects of transmission and distribution are planned. These include development of the 66 kV transmission system (with a third interconnector between the Connaught Bridge and Bungsar stations and the building of a 20,000 kVA substation at Rawang). To provide for long-term development it has been agreed that the 66 kV line to be erected from "Point E" between Connaught Bridge and Bungsar shall be insulated for 132 kV.

VIEWS on the NEWS

By REFLECTOR

AFTER many years I again paid a visit last week to the former Ipswich Corporation Electricity Department offices near the old power station (now used as a standby only). The interior of this rather sombre building has been considerably brightened and converted into the sales training centre described in the *Electrical Review* of 8th April. In company with Mr. E. A. Fowler, the Eastern Electricity Board's chief commercial officer, I joined one of the classes. Here a dozen or so young ladies were being given an insight into " consumer psychology " and shown how to deal with visitors to service centres (of which the Board has about 150). They were obviously keen to learn and the use of E.D.A. film strips with accompanying commentary was obviously a good way of stimulating that keenness. Such a scheme costs money but it should ultimately prove very remunerative to the Board. I was told that one unfortunate aspect is that some of the girls became so well trained that they are often tempted by higher pay to desert to " private enterprise " concerns. The remedy seems to be readily apparent but perhaps not so easy to apply in a nationalized undertaking.

* * *

Since the death of Mr. T. F. Cook in a motoring accident in 1952 the Electrical Trades Union has not had a representative of its Parliamentary Panel in the House of Commons. For the forthcoming General Election it will have two candidates:—Mr. J. Finnigan, who is standing for Cheltenham, and Mr. G. Scott, who is contesting the Edinburgh North seat. I understand that another member of the E.T.U. not on the Union's panel is also seeking election. He is Mr. R. Mawby, who is in the electrical contracting industry but whose political affiliations are not those which the Union supports. As the Conservative candidate for Totnes his prospects must be considered good as his predecessor in the last election was returned with a large majority.

* * *

After the bitter things which the *Evening Standard* has said about Lord Citrine in the immediate past it is pleasing to read its comments upon Lord Citrine's re-appointment as chairman of the Central Electricity Authority. It says that in the eight years he has been chairman of the Authority he has done " wonderfully well " and " his re-appointment in the job for another two years is wise, for at 67 he is at the peak of his powers." There is even a kind word for the Authority itself which is described as " one of the two Government enterprises which have given satisfaction." Overlooking the point that the C.E.A. is not a Government enterprise, I think this is handsome.

* * *

I learn that twenty meter readers in Doncaster, employees of the Yorkshire Electricity Board are to be given lessons by the R.S.P.C.A. on how to avoid being bitten by dogs in the course of their visits to consumers' houses. The introduction of the R.S.P.C.A. into this business suggests that the meter readers have been retaliating when bitten; otherwise the lessons would, I imagine, be offered by a meter readers' protection society. In any event it seems to be the dogs which need tuition, as no doubt local postmen and dustmen will agree.

* * *

My readers may recall that some time ago I mentioned the publication of the first of three volumes of a life of Lord Chatham, by E. O. Sherrard. I am told that John Lane is now publishing the second volume (" Pitt and the Seven Years' War "). The name of the author will be familiar to many electrical men for Mr. Sherrard was the solicitor and secretary to the Central Electricity Board up to the time of its dissolution in 1948.

* * *

Because, as he alleged, a street lighting standard interfered with his amenities, a resident at Hyde (Cheshire) asked the Council to move it. The Mayor is reported to have remarked at a Council meeting that they could not start moving lamp standards to suit the whims of residents, but in spite of this the Council decided that if he wanted the column removed the complainant must pay the full cost. If many residents objected to lamp standards and were willing to pay for their removal the effect upon the lighting system could be quite drastic. And what would be the position of a resident who objected to the erection outside his house of a standard for the removal of which a neighbour had paid?

* * *

Returning from a visit to Russia a party of members of the Electrical Trades Union recently told the Press what impressed them most during their stay. One thing was the complete absence of strikes in Russia for which, however, the delegation offered no explanation.

* * *

Fifty years ago the *Electrical Review* (19th May, 1905) referred to the forthcoming electrical exhibition and said that it was about time that such a display was arranged in view of the gas industry's activities in this direction. It compared the small short-period local exhibitions which had been held in this country up to then unfavourably with the permanent exhibition kept going by the Edison Illuminating Co., of Boston, U.S.A. The opinion was given that directors of British electricity supply companies were unwilling to spend money which did not secure direct profits. The other objection to exhibitions here was that

> " the average English professional man prefers to be dignified, even though he remain comparatively poor. One gentleman whose acquaintance with the business side of electricity supply was sufficient to make his opinion a criterion of the general sentiment of men in the profession stigmatized to us the schemes for increasing business above described as ' wild-cat.' "

Since that time there has been a distinct change of ideas; in fact exhibitions are now so frequent as to suggest that we are making up many years' arrears.

PERSONAL AND SOCIAL

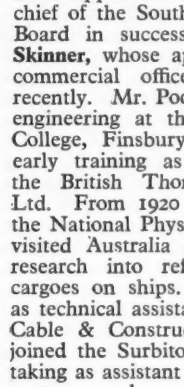
News of Men and Women of the Industry

The Minister of Fuel and Power has reappointed **Lord Citrine,** P.C., K.B.E., Comp.I.E.E., to serve as chairman of the Central Electricity Authority for another two years when his present term of office expires on 14th August next, and has also reappointed **Sir Henry Self,** K.C.B., K.C.M.G., K.B.E., to serve as deputy chairman of the Authority from the same date. Both Lord Citrine and Sir Henry Self have served as chairman and deputy chairman respectively since the Authority was first constituted in August, 1947.

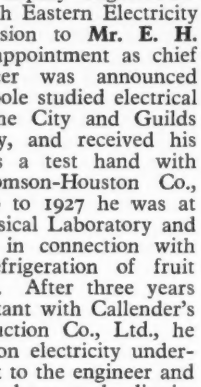
Mr. J. C. Poole, A.M.I.E.E., at present Woking district manager, has been appointed deputy engineer-in-chief of the South Eastern Electricity Board in succession to **Mr. E. H. Skinner,** whose appointment as chief commercial officer was announced recently. Mr. Poole studied electrical engineering at the City and Guilds College, Finsbury, and received his early training as a test hand with the British Thomson-Houston Co., Ltd. From 1920 to 1927 he was at the National Physical Laboratory and visited Australia in connection with research into refrigeration of fruit cargoes on ships. After three years as technical assistant with Callender's Cable & Construction Co., Ltd., he joined the Surbiton electricity undertaking as assistant to the engineer and manager and was later made district mains engineer. On nationalization of the industry Mr. Poole became senior planning engineer for Surrey Sub-Area and in 1954 was appointed Woking district manager.

Mr. E. Peel, A.M.I.E.E., succeeds Mr. Poole as manager of the Woking District. He previously held the position of district engineer.

Mr. Peel, who is thirty-nine, will be the youngest of Seeboard's district managers. He received his technical education at Blackburn Technical College and the Polytechnic, Regent Street, London, and started his career as a trainee with the Blackburn Corporation Electricity Department. Before enlisting in the R.A.F. in 1940 he spent a year at Maidstone. On demobilization in 1946 he was appointed as a mains assistant with Hammersmith Corporation and, under the London Electricity Board, became first assistant district engineer before joining Seeboard in 1954.

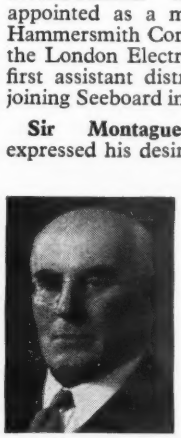


Mr. J. C. Poole



Mr. E. Peel

Sir Montague Hughman has expressed his desire to retire from the board of W. T. Henley's Telegraph Works Co., Ltd., at the annual meeting to be held on 3rd June. He has been a director of the company since 1924 and was chairman from 1933 to 1953 when he retired from that position and was succeeded by Sir John Dalton, the present chairman.



Sir Montague Hughman

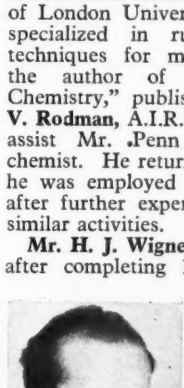
Sir Montague was born at Leeds in 1876 and was educated at St. Mark's College, Chelsea. He was trained as an assistant to the late Robert Hammond and was for many years engaged in engineering and shipbuilding in India. He is a vice-president of the B.E.A.M.A. and has been a vice-president and member of the Council of the Royal Society of Arts. He was a founder and hon. organizing secretary of the Institution of Engineers (India) in 1918-19 and acted as hon. secretary of the I.E.E. Indian Section from 1912 to 1921.

The South of Scotland Electricity Board announces the appointment of **Mr. E. Hill,** A.M.I.E.E., as commercial officer, Ayrshire Area. After apprenticeship with Hull Corporation Electricity Department, Mr. Hill held various posts in that Department and with the Yorkshire Electricity Board until 1949 when he was appointed assistant commercial engineer, West Kent District, South Eastern Electricity Board. In 1950 Mr. Hill became district commercial officer, Leyton District, London Electricity Board, and later transferred to the Wimbledon District. In 1953 he was appointed to his present post of commercial officer, Dumfries and Galloway Area.

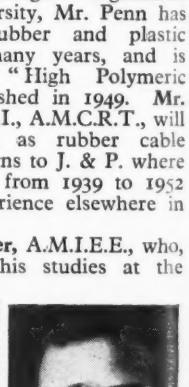
At the annual general meeting of the **Illuminating Engineering Society** held on 10th May the officers and new members of Council to take office in October were announced as follows:—President, Mr. A. G. Higgins (assistant secretary, Institution of Gas Engineers). Vice-presidents, Messrs. G. E. L. Comrie (Holophane, Ltd.), J. W. Howell (Lighting Service Bureau, Leeds), A. G. Penny (General Electric Co., Ltd.), R. W. Steel (South Western Electricity Board) and Dr. J. W. Strange (Thorn Electrical Industries, Ltd.). Hon. treasurer, Mr. E. B. Sawyer (Lighting Service Bureau). Hon. secretary, Mr. J. G. Holmes (Holophane, Ltd.). Hon. editor of *Transactions*, Mr. C. R. Bicknell. New members of council, Messrs. C. R. Bicknell (Siemens Electric Lamps & Supplies, Ltd.), H. Carpenter (Blackpool Corporation), W. E. Rawson-Bottom (Ministry of Works), John Reid (architect), N. C. Slater (W. J. Furse & Co., Ltd.), W. J. P. Watson (Holophane, Ltd.), A. H. Young (Troughton & Young, Ltd.) and Dr. H. F. Gillbe (Ministry of Transport).

Mr. W. S. Penn, B.Sc., has joined Johnson & Phillips, Ltd., as chief rubber cable technologist. A graduate of London University, Mr. Penn has specialized in rubber and plastic techniques for many years, and is the author of "High Polymeric Chemistry," published in 1949. **Mr. V. Rodman,** A.I.R.I., A.M.C.R.T., will assist Mr. Penn as rubber cable chemist. He returns to J. & P. where he was employed from 1939 to 1952 after further experience elsewhere in similar activities.

Mr. H. J. Wigner, A.M.I.E.E., who, after completing his studies at the Northampton Engineering College, was with Johnson & Phillips, Ltd., as a student apprentice and later served in the Transformer Department, has now rejoined the company as senior sales engineer after experience on the sales staff of other companies.



Mr. W. S. Penn



Mr. H. J. Wigner

Mr. L. C. Mainwood, electrical engineer, H.M. Stationery Office, Works Division, retired on 13th May after thirty-five years' service, during the past twenty years of which he was in charge of the Electrical Department responsible for the electrical installation and maintenance services for the

Works Division. At a gathering of friends and colleagues in the Harrow Works on 13th May, in the presence of Mr. H. Pickford, assistant controller, Mr. J. P. Turner, director of works, and Mr. J. B. Kearsey, chief engineer, Mr. D. E. Masson, senior works manager, presented Mr. Mainwood with a number of gifts as a token of their good wishes. Mr. Mainwood's successor is **Mr. E. H. K. Palmer,** B.E.M., A.M.I.E.E.

Sir Patrick Hamilton, Bart., has been appointed vice-chairman of the Expanded Metal Co., Ltd. Sir Patrick is the son of the late Sir George Hamilton who was chairman of the company until his death in 1947.

Following upon the resignation of Mr. J. R. Ferguson from the Crompton Parkinson, Ltd., associate company Cooke & Ferguson, Ltd., the appointment is announced of **Mr. A. F. Kistner** as general manager of the Cooke & Ferguson switchgear works in Manchester. This appointment took effect as from 1st May. Mr. Kistner's service with Crompton Parkinson, Ltd., dates back to 1927 when he commenced his apprenticeship training at the company's Chelmsford works. In 1933 he was appointed sales engineer in the plant division, and two years later took up duties with the company's agents in Hong Kong. In 1937 he joined the company's agents in Bombay. The year before the outbreak of hostilities in 1939, he returned to this country as a plant sales engineer at the C.P. Manchester office. During the war years he served as a lieutenant-colonel with the Royal Corps of Signals and on the cessation of hostilities rejoined the company, subsequently taking up duties on the staff of the works director. In 1950 he was elected a member of the Crompton Parkinson junior board.

Mr. A. F. Kistner

A new Electronics Department has been formed by the Metropolitan-Vickers Electrical Co., Ltd., Trafford Park, Manchester, which incorporates the present Radio Department, part of the Marine and Special Contracts Department, and the service electronics section of the Industrial Electronic Control Engineering Department. The industrial section of the Industrial Electronic Control Engineering Department has been renamed the Industrial Process Control Engineering Department. The following officials of the Electronics Department have been appointed:—Superintendent, **Mr. E. T. W. Barnes** (formerly superintendent, Radio Department); assistant superintendent, **Mr. D. E. Thornhill,** B.Sc.(Tech.), Graduate I.E.E.; chief engineer, **Dr. L. W. Brown** (formerly chief engineer, Radio Department); assistant chief engineer, **Mr. T. R. Goode** (formerly assistant chief engineer, Radio Department); assistant chief engineer (special applications), **Mr. J. L. Russell,** A.M.I.E.E.; sales manager, **Mr. L. H. J. Phillips** (formerly sales manager, Radio Department); assistant sales manager, **Mr. J. Nicholson** (formerly assistant manager, Marine and Special Contracts Department). **Mr. G. W. G. Canter,** formerly manager, Marine and Special Contracts Department, has been appointed manager, special contracts, and will be in London.

Mr. D. E. Thornhill

Mr. J. L. Russell

Mr. E. V. Small

Mr. D. N. Relf

Mr. Thornhill joined M-V as a vacation apprentice in 1936. After technical education at the Manchester College of Technology and completion of trade and college apprenticeships, he became a junior engineer in the Instrument and Meter Department in 1946. Two years later he transferred to M-V's subsidiary company, Newton Victor, Ltd., as development engineer at the Motherwell Works.

Mr. Russell received his technical education at the Manchester College of Technology. After a trade apprenticeship with M-V from 1936 to 1940 and a period in the Plant Department drawing office he joined the Railway Signals Department as a junior engineer. In 1947 he moved to the Electronic Control Engineering Department, where he has been section leader, special contracts, since 1949.

Mr. E. V. Small, managing director of the British Thomson-Houston Export Co., Ltd., has been elected to the board of the British Thomson-Houston Co., Ltd. Mr. Small, after military service in the 1914-18 war, entered upon a student apprenticeship at the B.T.H. Rugby Works, and in 1920 was awarded a fellowship which took him to the United States for a one-year study of American design and shop practice. On his return in 1921, he joined the staff of the B.T.H. Export Department and between 1923 and 1947 served the company in India, being managing director of Associated Electrical Industries (India), Ltd., from 1935 to 1947. Mr. Small returned to England in 1947 on being appointed director and general manager of the B.T.H. Export Co., and in 1949 was appointed managing director of that company.

Mr. D. N. Relf, M.B.E., A.M.I.E.E., has been appointed by the British Thomson-Houston Co., Ltd., as assistant manager, switchgear contracts, Willesden. After a period at Kingston Technical School and afterwards at Acton Technical College, Mr. Relf in 1930 entered upon an apprenticeship course at the B.T.H. Willesden Works, on completion of which he entered the drawing office, transferring to the Engineering Department in 1938. From 1941 to 1946 Mr. Relf served in the Royal Air Force, being commissioned as a pilot and attaining the rank of flight-lieutenant. On demobilization he rejoined the B.T.H. Co. in the Switchgear Contracts Department, and in 1950 assumed executive responsibility for the export section of that department.

Mr. A. R. Younger, managing director of Fractional H.P. Motors, Ltd., accompanied by **Mr. D. R. Thomas,** secretary, and **Mr. C. E. Collin,** works manager, will be flying to Sweden on 22nd May in connection with an important contract secured for fractional h.p. motors.

The British Transport Commission announces the appointment as supplies and production adviser to the Commission of **Mr. E. L. Gethin,** B.Sc., A.M.I.E.E., at present deputy chief contracts officer at the London headquarters of the Central Electricity Authority. Mr. Gethin, who will take up his new appointment on 13th June, will be responsible for the proper utilization of the Commission's industrial facilities, and for the co-ordination of its purchasing programmes. The appointment is of special importance in view of the £1,200 million programme for the modernization and re-equipment of British Railways.

Mr. F. L. Gethin

Mr. Gethin was trained at Faraday House and took an honours B.Sc. degree in engineering at London University, and thereafter served a two years' college apprenticeship course with the Metropolitan-Vickers Electrical Co., Ltd., at Trafford Park and at their traction works at Sheffield. After a further year in the estimating

section of the Motor Department in this company he joined Edmundsons Electricity Corporation, Ltd., in 1930. He remained with the Edmundsons group of companies until nationalization in 1948, becoming assistant purchasing agent in 1935 and in 1940 purchasing agent, being responsible for all capital purchases for the group. On nationalization Mr. Gethin was appointed chief purchasing officer of the Southern Electricity Board and a few months later (in July, 1948) he was appointed specifications and contracts engineer at the headquarters of the British Electricity Authority. Upon the setting up of a separate Contracts Department in 1950 he was appointed to his present position of deputy chief contracts officer. Mr. Gethin is a member of the Purchasing Officers' Association.

Mr. S. R. B. Brewer, B.Sc., A.M.I.E.E., who has for many years occupied senior engineering positions with the Bryce Electric Construction Co., Ltd., has been appointed sales manager of the company.

Mr. S. R. B. Brewer

The forty-third annual general meeting of the British Engineers' Association, with the president, Mr. H. S. Broom, M.B.E., in the chair, was held on 12th May. As a result of the ballot for election to the Governing Council of the Association, **Mr. W. T. Towler,** J.P. (Towler & Son, Ltd.), and **Mr. G. S. Wood** (Thomas W. Ward, Ltd.) were elected as new members of the Council.

The following changes are announced on the board of the Kenwood Manufacturing Co., Ltd.:—**Mr. J. Lecker,** a director of A. Hurst & Co., Ltd., Kenwood's export managers, and **Mr. C. Sidebothom,** managing director of Wholesale Supplies (Swinton), Ltd., Manchester, join the board. **Mr. O. S. Ruane** and **Mr. Robert C. Cox** resign from the board. Announcing these changes, Mr. Ken Wood said that holdings in the Kenwood Manufacturing Co., Ltd., have been acquired by the B.E.T. Group and another financial interest and also by A. Hurst & Co., Ltd.

Mr. R. W. McCrone is retiring from the chairmanship and board of Metal Industries, Ltd., to enable him to devote his attention to other interests; he is succeeded by the vice-chairman, **Mr. J. S. Hutchison.** It is proposed that Mr. McCrone shall be appointed an honorary president of the company. **Sir Charles Westlake,** who retires from the position of chairman of the Uganda Electricity Board on 1st October next, has been appointed a director of Metal Industries, and **Mr. J. O. Knowles,** chairman and joint managing director of Brookhirst Switchgear, Ltd., and **Mr. J. T. Rymer,** managing director of Sentinel (Shrewsbury), Ltd., have also joined the Metal Industries board. Messrs. Knowles and Rymer will maintain their connections with their present companies which are members of the M.I. group.

The N.W. (Manchester) Area Qualifying Competition of the **E.I.B.A. National Golf Championship** was held on the course of the Stockport (Torkington) Golf Club on 4th May. Cards were taken out by 130 competitors and a number of non-playing friends gave their support to the meeting. The golf prizes were presented by members of the Manchester Branch of the Electrical Contractors' Association, and there were many other prizes. The day's effort resulted in a sum of £200 being raised for the E.I.B.A. funds.

Mr. W. Gardner has been appointed manager of the Manchester Branch of Drake & Gorham Wholesale, Ltd. He was formerly with Electrical Components, Ltd.

The annual general meeting of the **Exeter Electric Club** was recently held at the Imperial Hotel, Exeter. The retiring president, Mr. G. S. Mogridge, thanked all members for their support in what had been a very successful year and he wished his successor a very prosperous year of office. The officers elected were:—President, Mr. H. F. G. Bicker; vice-president, Mr. P. C. Tracy; hon. treasurer, Mr. J. Rothera; hon. secretary, Mr. A. W. Hicks.

Mr. R. Hardie has been appointed a director of Richard Johnson & Nephew, Ltd. He will continue to act as secretary.

Mr. R. T. Griffiths has been appointed home sales manager of Hoover, Ltd. After a career in the Royal Air Force, Mr. Griffiths joined Hoover, Ltd., as a sales-service representative, becoming a district manager in 1946. In 1947 he was made northern branch sales personnel manager, in 1948 manager and before his new appointment was field sales manager, a post he had occupied since August, 1953.

Mr. R. T. Griffiths

Mr. Glenn E. Wallichs, co-founder and president of Capitol Records Inc. has been elected to the board of Electric & Musical Industries, Ltd.

At the recent annual meeting of the Liverpool Centre of the Illuminating Engineering Society **Mr. G. L. Butler** (G.E.C.) was elected chairman, in succession to Mr. G. W. A. Illingworth (lighting engineer, Southport). Other appointments made were: vice-chairman, Mr. F. J. Burns (Cryselco); hon. treasurer, Mr. W. T. Trace (W. H. Trace & Son, Ltd.); and hon. secretary, Mr. J. L. McCauley (G.E.C.).

British Insulated Callender's Cables, Ltd., announces that **Mr. H. Thomson** has been appointed branch manager at Glasgow. Mr. Thomson was educated at Knowetop Public School, Motherwell, Glasgow High School and the Royal Technical College, Glasgow, where he obtained a diploma after completing a course of electrical engineering. His student apprenticeship was served with R. M. Russell, Ltd., Glasgow, and Bruce Peebles & Co., Ltd., Edinburgh, with whom, before the war, he acted as a transformer sales engineer. He served with the R.N.V.R. between 1940 and 1946 and on demobilization joined B.I.C.C. Before his appointment as branch manager he was sales engineer at the company's Glasgow office.

Mr. H. Thomson

At the meeting of the Council of the Public Transport Association held on 12th May **Mr. E. L. Taylor** retired from the chair of the Association which he has occupied since 1953. The new officers are **Mr. John M. Birch,** chairman, and **Mr. T. Robert Williams** and **Mr. P. G. Stone Clark,** who were elected vice-chairmen for the ensuing year.

At the monthly luncheon last Tuesday of the **Electrical Industries Club** Mr. R. Baldwin presided and the guest speaker was Mr. L. Ring, of Ring & Brymer, Ltd. Mr. Ring gave a most interesting and amusing talk on traditional catering in the City of London with which his firm has been connected for nearly 300 years.

OBITUARY

Mr. Maurice F. Lodge died on 25th April at the age of fifty-three. He began work as a boy at Ingham's Collieries & Bye Products Plant at Thornhill, Dewsbury, becoming head electrician in 1933, a position he held until 1949 when he was appointed group electrical engineer for No. 2 Group in the National Coal Board's North Eastern Division, No. 7 (Wakefield) Area.

Mr. George Thomas Webster, who during the past ten years represented the "Atlas" lighting division in Hampshire for Thorn Electrical Industries, Ltd., has died after a prolonged illness.

Mr. Edwin Percival Allam, founder and director of E. P. Allam & Co., Ltd., died at his home in Boscombe on 8th May. He was eighty-six.

LETTERS TO THE EDITOR

Letters should bear the writers' names and addresses, not necessarily for publication. Responsibility cannot be accepted for the opinions expressed by correspondents.

"Freedom of Expression"

WITH reference to the leader in your issue of 6th May, it is obvious that some recent happening was probably behind this point of view.

At the recent E.D.A. Annual Conference there was a very pointed reluctance by delegates of the London Electricity Board to support the papers presented at the Conference, but the delegates from other Area Boards who in recent months have started a trend for greater co-operation with the staff were more spontaneous in supporting the authors of the papers presented.

It is a sad state of affairs when staffs feel that freedom of expression at conferences sponsored by the nationalized industry and to the electrical Press will probably retard careers and promotion in any future re-organization.

I personally believe that this lack of expression is one of the most important reasons why there is apathy in connection with joint consultation and the experiences of many keen men and women are withheld—hence complacency.

Upminster, Essex. J. K. WILKINS.

YOU did well in your leader of 6th May to urge that "the free interchange of knowledge and experience is not merely an aspect of democracy, it is essential to the advancement of science and industry." It is timely counsel. The steady re-shaping of organizations of all kinds into authoritarian forms is prejudicing individual expression and betterment; and it is ironic that even bodies such as trade unions and professional institutions are succumbing.

I point to this general aspect because, as you said, inhibitions can exist in a private as well as in a publicly-owned organization. Your criticism was directed at only one industry (that of electricity supply)—with the observations that in this particular industry articles dealing with policy matters must be "passed for press," and that official scrutiny should be needless when an author states that he expresses personal views only.

Your selection of the Central Electricity Authority and the autonomous Area Boards was obviously deliberate. But these are not the only supply authorities in the British Isles, and they are very far from being the only employing bodies concerned with engineering. Moreover, policy is not the only subject that could cause contention. There should be an accepted Code of Conduct for technical writers generally—the Code to apply not only for articles but also for papers and addresses to professional institutions and the like. The Code could consist of two rules:—

> Rule 1:—A writer shall not make written or pictorial reference to his employer's own specialized equipment, policy, and day-to-day routine without permission and without making due acknowledgment in his script, but he shall be at liberty to use any contribution of his own which has been rejected unless (by his contract of employment) this is forbidden; and he shall be at liberty to deal with any other topic whatsoever.
>
> Rule 2:—A writer shall not use any of his normal working time or of the employer's materials, plant, staff or office resources unless he is in effect reporting for the employer.

These rules touch upon a number of issues; they are necessary, leading to honesty of purpose and action; and no writer need regard them as repressive. No novelty, either ethical or practical, is claimed for them.

I venture to send my views on the strength of former experience as a writer, having published three papers and several score technical articles. For the most part these appeared during the years between the two world wars, your journal, indeed, accepting my first article in 1919 and then a goodly share of my later output. Throughout I observed the Code set out above; in practice, this resulted in most of my experiments and all MS. preparation being carried out at home.

One cannot help feeling that technical writers of the last generation found more encouragement and opportunities than the scribes of to-day. Your leader may help to win back some of the lost freedom, and thus bring more interest and excitement into the workaday life of all of us.

Darlington. G. E. MOORE.

Registration and Inspection

HAVING for some time been Government Senior Electrical Inspector to the Union of Burma and during this tour of duty introduced the compulsory registration and licensing of electrical contractors here I was very interested to read that a National Inspection Council has been set up for the same purpose in the United Kingdom.

I would be very glad to know what is the yardstick by which contractors' work is to be measured and judged. It was easy to license a contractor in Burma because we knew the standard of work would improve and the only standard we demand is a clean safe job carried out with a safe system and reasonably good material but in England surely most of the contracting work is good and very few contractors need telling that 3/·029 cable is the smallest size which should be used.

Before nationalization the very many supply authorities had their own regulations and some were very strict; some stuck mainly to I.E.E. Rules while others had regulations that simply did not make sense. Is it proposed to draw up a set of rules and regulations to cover all contractors and to apply in all areas?

In Burma, any person can be fined for carrying out installation work without a licence and so can the person for whom it was carried out. Is it proposed to bring into force any such legal action against unlicensed contractors in the United Kingdom?

Rangoon. J. A. HILL,
Senior Electrical Inspector,
Government of Burma.

TURKISH WATER POWER PROJECT

Work has started on the construction of a large dam and hydro-electric power station at Demirköprü, on the Gediz River, north of Izmir, Western Turkey. This plant, one of the major units in the Turkish grid, will cost about £T200 million. Planned by a New York firm of consulting engineers, the contracts for the new project were awarded to a Franco-Turkish enterprise. When ready for operation in April, 1958, its 70,000 kW plant will generate 190 million kWh per annum, provide water to irrigate over 100,000 hectares of agricultural land and control floods in the Gediz Valley.

Wages and Overtime

E.T.U. Conference Discussions at Worthing

OVERTIME and working conditions rather than basic wages were the main subjects discussed at this year's Policy Conference of the Electrical Trades Union which opened at Worthing on Sunday. Normally the delegates are able to enjoy a period of leisure at the week-end before the proceedings begin but this year an earlier start was made so that members would be able to return home as soon as possible to take part in the General Election campaign. To the same end there was considerable " streamlining " of the business of the conference and on Monday alone no less than sixty motions were withdrawn, referred to the Executive Council or (in the case of three) replaced by a special composite resolution.

After the Mayor of Worthing had extended a civic welcome to the 340 delegates on Sunday morning Mr. F. Foulkes delivered his presidential address. Speaking of strikes, and obviously referring particularly to the recent dispute in the newspaper industry, he said that exception had been taken to the fact that the leadership of the Union kept in step with the rank and file and supported the members in the airing and rectifying of grievances. The strikes in which the members had taken part had been constitutionally correct and had been controlled within the democratic structure of the Union, which allowed the members themselves to decide to withdraw their labour by democratic vote.

On the general question of wages, the president said that for the first time wage increases in the major industries during the last six months had been in keeping with the figures used in the official interim index of retail prices; they had not, however, been sufficient to meet the actual rise in prices although a small portion of the increased values created as a result of greater productivity had been returned to the workers. These new wage levels must be maintained and the surplus values derived from higher productivity must be increasingly reflected in the wage packets. Profits in British industry in 1954 were up by nearly 20 per cent and ordinary share prices had reached values higher by an average of 34 per cent.

Shorter Working Week Advocated

Saying that the prerequisite of good health was greater leisure, Mr. Foulkes declared that alongside the fight for higher wages it was necessary to strive for a reduction in the number of hours worked. Inflated earnings due to overtime were used by employers during wage negotiations to resist demands for increases in basic rates. It was necessary, therefore, to campaign against overtime and for a shorter working week, even though this might entail a temporary lowering of the standard of living that had only been maintained by the working of systematic overtime.

In the course of his address Mr. Foulkes also spoke of the progress of the drive to recruit women members and said they were under obligation to fight for women to enjoy, as a minimum, the equivalent of the male labourer's rate, with equal pay on established rated jobs.

During the year the Union had submitted evidence to the Monopolies Commission inquiring into the heavy electrical plant industry and also to the Herbert Committee on electricity supply.

The president's observations on overtime were carried a stage further in a special Executive Council motion adopted by the conference. While recognizing the need for occasional overtime work this " viewed with grave concern the apparent attempt to weave into the pattern of industrial life constant and excessive overtime work." This practice, it was contended, deprived the workers of their leisure, interfered with their family life and civic and social activities, and was injurious to their health. Moving the resolution on behalf of the Executive Council, Mr. F. L. Haxell, the general secretary, said that in electrical engineering and electrical contracting the latest figures showed that the average number of hours worked each week was 49½. This was exactly the same as before the war, so that in fact no advance at all had been made by the workers. In the discussion it was indicated that the availability of overtime was an inducement to many members to take on jobs and even shop stewards were not inclined to believe that it would eventually lower the standard of living. On Clydeside there were " floating squads " going from job to job, induced by overtime. Some members had refused to carry out a ban on overtime. The secretary quoted from a letter asking for the names of firms taking on men; the only stipulations were that there should be a generous lodging allowance and an average of 80 hours' work a week. One member drew attention to a motion on " planning for full employment " which said, *inter alia,* that foreign Governments should be encouraged to place orders with British shipyards. How could this be done if overtime was banned?

Contracting Industry Claim

The next resolution dealt with the wages of electricians in the contracting industry and in the course of the discussion it was disclosed that a claim was to be made for a further increase in addition to that recently agreed to.

The Executive Council was urged to continue to press for an increase in the wages of apprentices in the electrical industry. Superannuation and sick pay for all workers and a 40-hour week were other aspirations supported by the conference.

Another aspect of the question of working hours arose during the debate on resolutions concerned with the electrical contracting industry. In one of these the Executive Council was urged to pursue negotiations with the National Federated Electrical Association and the Electrical Contractors' Association of Scotland for a five-day working week.

During the conference addresses were given by Dr. Hugh Price, a member of the Executive Committee of the Socialist Medical Association, and by Mr. J. Scott, chairman of the Railways Sub-Committee of the Confederation of Shipbuilding and Engineering Unions. Dr. Price said there was a great need for an occupational health service. Many substances were used in industry to-day the long-term effects of which were not known. It was up to the unions to see that every type of employment hazard was investigated and from their own records to show in what ways the health of their members was being affected.

A welcome was extended to two delegates from India, Haren Mukherji and Markandey Jha, joint secretaries of the Calcutta Electricity Supply Union, who presented as gifts to the E.T.U. two examples of craftsmanship in wood,

an electric lamp standard fashioned as a lotus flower, and a sandalwood box.

On the Union's organization and structure, the Executive Council's report records an increase in membership last year from 211,512 to 215,596. At a special rules revision conference held at Bournemouth changes were made with the object of meeting rising expenditure. These included a new weekly scale of contributions with a full rate for skilled members of 1s 7d, and economies in administration. The report also records that 473 members spent a fortnight at the Union's convalescent home at Rustington during the year and 35 courses were held at the E.T.U. College at Esher.

Cathodic Protection

The first course to be held by the electricity supply industry dealing with the cathodic protection of buried cables was held at Stowmarket, Suffolk, on 10th and 11th May. Organized by Mr. G. N. Green, chief engineer of the Eastern Electricity Board, the programme included fundamental principles, methods of testing, maps and records. Practical demonstrations of methods of testing were given on a model system and general policy procedure was outlined.

In this country comparatively little trouble has so far been experienced due to corrosion on the sheaths of buried cables belonging to the electricity supply industry. Other public utilities with buried mains or pipes have not always been so fortunate. To reduce corrosion troubles many of them have been steadily turning to the use of cathodic protection. However, in protecting one system it is possible to cause damage to another, and it has been realized within the last year or two that some co-ordination is necessary, otherwise the faults experienced by the supply industry may well increase.

For this reason a joint committee, representing many of the interests concerned, has been set up. In addition, the conference of the Central Electricity Authority with Area Board chief engineers has formed a special panel of its Cables Committee to deal with cable corrosion and cathodic protection.

This panel considered that information on the technique of cathodic protection and the necessary testing associated with it could not be adequately circulated to engineers of Area Boards merely by the distribution of recommendations and reports. It was felt that practical demonstrations would be of greater benefit.

Southend Line Electrification

An order has been received by the British Thomson-Houston Co., Ltd., for the whole of the electrical substation and track-section cabin equipment for the extensions to the Liverpool Street-Shenfield electrified line to Chelmsford and Southend (Victoria). This is the first order to be placed for new inter-urban line electrification equipment since the war, and marks the beginning of the long-term modernization and re-equipment programme to be undertaken by the British Transport Commission.

The electrification extension covers two sections of the main line from Shenfield to Chelmsford on the line to Ipswich, and from Shenfield to Southend (Victoria), a total of 32 route miles. Five 2,000 kW, 1,500 V pumpless steel tank rectifier equipments are to be supplied and will be installed in four substations at Hylands, Ramsden Bellhouse, Rayleigh and Prittlewell, the last-named being a two-unit substation near the Southend terminal.

The a.c. switchgear comprises 33 kV, 500 MVA and 750 MVA Class MF.36 single busbar equipment, and at Prittlewell non-automatic circuit-breakers are provided for bus section and incoming isolation. A special feature of the a.c. switchboard is the provision of 30 kVA, 33,000/650/415/240 V plug-in type auxiliary transformers to supply 10 kVA three-phase substation auxiliary and 20 kVA single-phase signal circuits. The 650 V supplies for signalling equipment are taken through a Brentford regulating transformer (mounted on the pedestal housing the auxiliary transformer) so as to maintain the signal supply at 650 V within ±1 per cent. At the three substations from which the signalling supplies are taken, the auxiliary transformers are duplicated with suitable change-over facilities.

Each rectifier equipment will be designed for twelve-phase operation and comprise two Type MB.6/16 rectifiers mounted on withdrawable truck-type underbases and housed in separate cubicles. Some of the substations are in residential areas and special low-speed rectifier ventilating fans will be employed to ensure that they operate without undue noise. The 1,500 V d.c. high-speed circuit-breakers are to be of the truck-mounted RJR.712 type operated from the track by supervisory control.

The four substations and four track-section cabins will be controlled from the existing supervisory control station at Chadwell Heath where the present S.T.C. control desk and equipment are being modified to provide improved facilities and to allow for the new extensions. As the main contractor the B.T.H. Co. is responsible for the supply and installation of the whole of the electrical equipment, including the supervisory equipment, batteries, and substation lighting, heating and ventilating equipment.

Parliamentary Candidates

As on the occasion of previous General Elections the two principal political parties have provided us with lists of their candidates. From these we have selected those with electrical affiliations in so far as these are indicated. An asterisk denotes that the candidate was a member of the last Parliament.

The Conservative Party list includes the following:—Mr. J. W. Bissell (Birmingham, Small Heath), maintenance electrician, member A.E.U.; Sir William Darling* (Edinburgh, South), chairman, Bruce Peebles & Co., Ltd.; Mr. J. Eunson (Orkney and Zetland), with North of Scotland Hydro-Electric Board; Mr. F. J. Erroll, A.M.I.E.E.* (Altrincham and Sale), formerly Parliamentary contributor to the *Electrical Review;* Mr. B. de Ferranti (Manchester, Exchange), departmental manager, Ferranti, Ltd.; the Hon. J. Grimston* (St. Albans), director, Enfield Rolling Mills, Ltd.; Mr. R. L. Mawby (Totnes), electrician, member E.T.U.; Mr. C. I. Orr-Ewing, O.B.E., A.M.I.E.E.* (Hendon, North), A. C. Cossor, Ltd.; Mr. G. Peters (Newcastle-upon-Tyne, Central), electrical tester, member A.E.U.; Councillor J. Poole (Coventry, North), director of an electrical company; Mr. H. Macdonald Steward* (Stockport, South), works development engineer, British Insulated Callender's Cables, Ltd.; and Mr. J. Whiteley (Salford, East), partner in an electrical engineering and contracting firm.

Among the Labour Party candidates are the following:—Mr. R. L. Fagg (Tonbridge), a Post Office engineer; Mr. J Finnigan (Cheltenham), electrical fitter; Mr. J. Frater (Berwick), electrical tester; Mr. C. R. Hobson* (Keighley), power station engineer; Mr. A. K. M. Milner, A.M.I.E.E. (Woodford), electrical engineer; Mr. A. M. F. Palmer, A.M.I.E.E.* (Cleveland), editor of the *Electrical Power Engineer* and Parliamentary contributor to the *Electrical Review;* Mr. G. Scott (Edinburgh, North), electrician; the Rt. Hon. R. R. Stokes* (Ipswich), chairman and managing director, Ransomes & Rapier, Ltd.; and Mr. W. Vernon* (Camberwell, Dulwich), electrical engineer.

Moulded Magnetic Materials

In connection with the article on this subject in our last week's issue we should have mentioned that the author, Mr. G. R. Polgreen, is chief engineer with Salford Electrical Instruments, Ltd.

INDUSTRIAL NEWS

Bennis Combustion Agreement

It is announced by Bennis Combustion, Ltd., that, following on an agreement with Todd Oil Burners, Ltd., of London, it is now able to execute complete oil burning installations for shell type and water-tube boilers. Todd Oil Burners, Ltd., an associate company of the Todd Shipyard Corporation of New York, has produced in this country a full range of oil burners for all applications.

Electrical Manufacture in North-East

The report of the North-East Development and Industrial Association for 1954 states that it is particularly encouraging to note the growth of the region's electrical manufacturing industry. If the rate of expansion in recent years continues, the North-East will have a new basic industry comparable in size and potentiality with the chemical industry. The number of workers employed in the manufacture of electrical goods last year was more than 19 times as high as before the war, while the number making electrical machinery had increased by over 40 per cent.

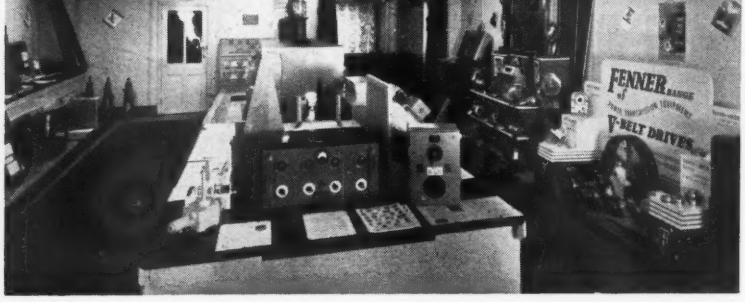
Wholesalers' Industrial Exhibition

Furse Wholesale, Ltd., Nottingham, recently staged an exhibition of industrial electrical equipment in their showroom, which had been temporarily cleared of its normal domestic lines. The object was to enable local industrial concerns to see the type of apparatus now available in the fields of electrical installation, automatic control and maintenance.

The exhibitors included Newman Industries, Ltd., who showed a range of electric motors from the smallest type up to 200 h.p., and including a special flameproof design incorporating features called for by the National Coal Board. Also on show on this stand was a range of motors to the new British Standard dimensions. Londex, Ltd., had a display showing the applications of automatic control and electronics to industrial problems. The Wolf range of electric tools indicated the many uses for which these are now designed. Other items were concerned with Thorn unit dust extractors, Furse lightning conductors and accessories and Fenner industrial drives employing "V" belts, torque-arm speed reduction gear boxes and Hainsworth variable speed pulleys. A special display was devoted to Brush high rupturing capacity fuses. On the maintenance side, a range of "Actarc" welding equipment was also on show.

Telecommunications Equipment for Brazil

The Companhia Telephonica Brasileira, Brazil, has placed substantial contracts with Standard Telephones & Cables, Ltd., through the associated Standard Electrica S.A. of Brazil. These contracts include equipment for a complete multi-channel coaxial cable route and a super-high-frequency radio network also for multi-channel telephony. The coaxial cable route, representing the first link in the proposed Brazil network, which will be brought into operation early this year, has been installed between Rio de Janeiro and Petropolis, 65·5 km to the north of the capital. Expanding traffic requirements on this route are catered for with a 4-tube coaxial cable potential capacity which, with a full complement of associated multi-channel carrier systems equipment, will be 1,920 speech circuits. Supervisory and control facilities for intermediate repeater stations are provided for by interstice pairs. For a third of its length, this cable has been laid in specially constructed ducts, but the remainder of the cable has been laid in open ground and is therefore of the armoured type. The radio network covers a distance of approximately 300 miles and will link Sao Paulo to Rio de Janeiro and also to Campinas.



A display of industrial electrical equipment at the showroom of Furse Wholesale, Ltd., Nottingham

Canadian Cable Company

Mr. J. R. Bradfield, president of Canada Wire & Cable Co., Ltd., has announced the completion of arrangements with General Cable Corporation of the United States for the formation of a company for the manufacture of telephone cables in Canada. The new company, Telecables & Wires, Ltd., will be under the management of Canada Wire & Cable Co. The plant will be at Winnipeg.

H.P. and Gas Cookers

It is complained by the chairman of Cannon Industries, Ltd., that the introduction of hire-purchase control, instituting a high initial deposit, has resulted in a severe fall in the demand for gas cookers. This has necessitated the standing-off of nearly 200 operatives at the company's Deepfields works, Coseley, Staffs.

Prices of Materials

In the accompanying table we give the basis prices of the more important materials used in the electrical industry. The figures given are the selling prices and are those quoted on Tuesday last.

ALUMINIUM Ingots	ton £163 0s 0d
COPPER, H.C. Electro	ton £321 10s 0d
Fire Refined 99·70%	ton £320 0s 0d
Fine Refined 99·50%	ton £319 0s 0d
COPPER Tubes ..	lb 3s 1d
Sheet	ton £387 5s 0d
H.C. wire and strip ..	ton £360 0s 0d
LEAD, English ..	ton £103 10s 0d
Foreign	ton £102 0s 0d
MERCURY	flask £108 0s 0d
TIN, block (English) ..	ton £713 10s 0d
ZINC, G.O.B. Foreign	ton £89 15s 0d
Electrolytic	ton —
BRASS Tubes (solid drawn)	lb 2s 5½d
Sheet	ton £309 10s 0d
Wire	lb 3s 1½d
PHOSPHOR BRONZE Wire	lb 4s 7½d
PLATINUM	oz £29 0s 0d
RUBBER, No. 1 R.S.S. spot	lb 28½d—28⅝d

Canadian Welding Code

Considerable efforts have been made by the British Standards Institution to help exporters of engineering equipment to meet the various standards and certification requirements existing in Canada. The certification of welded fabrications (unlike that of electrical equipment) is not a mandatory requirement in Canada, but more and more Canadian buyers are asking that major

fabrications should be certified to the requirements of the Canadian Welding Bureau. These requirements involve the certification of individual welding operators employed on the particular item, as well as a complete investigation of the manufacturer's factory and plant. Up to now there have been no means whereby certification could be obtained in the United Kingdom, and application of the entire scheme to manufacturers here who sell very few certified welded fabrications to Canada would have been economically impracticable.

Bearing on the above the Institution has just published a new booklet entitled "Information on the Canadian Welding Qualification Code." This sets out in detail both the procedure adopted in Canada for certification of welded fabrications and the arrangements now agreed for carrying out this work in the United Kingdom. Copies of the booklet in question can be obtained on request from the B.S.I./CSA Approvals Agency, British Standards Institution, British Standards House, 2, Park Street, W.1.

The Brighton Convention

Delegates to the Seventh British Electrical Power Convention at Brighton (27th June-1st July) have now received the complete programme and applications for tickets. They are reminded that the application forms must be returned to the secretary by 27th May. The proceedings follow the lines set out in the preliminary programme (*Electrical Review*, 4th February, p. 182). The forms include applications for entry to the golf competition and a question form in connection with the "Electrical Forum."

Edinburgh Ideal Home Exhibition

One of the attractions at the Edinburgh Ideal Home Exhibition, which was held from 27th April to 14th May, was the stand of the South of Scotland Electricity Board. The theme of the display was the "Four Foundations of Modern Living," electric cooking, refrigeration, water heating and the home laundry. Live demonstrations figured prominently in the general attractiveness of the stand.

Part of the display of the South of Scotland Electricity Board at the Edinburgh Ideal Home Exhibition

Transformers for the United States

Ferranti, Ltd., have again been successful in being awarded contracts for the supply of transformers to the United States. The contracts are for the supply of one 8/10 MVA 110 kV 3-phase power transformer for West Fargo, North Dakota, and for one 10 MVA 110 kV 3-phase power transformer for Yankton, South Dakota. Both are part of the Missouri River Basin Project. The value of the contract is $130,000, and it was obtained in face of keen competition from many American and European sources.

Band III Television Transmitters

The B.B.C. has ordered two pairs of television transmitters from Marconi's Wireless Telegraph Co., Ltd., for the proposed alternative programme service, and in anticipation of the allocation of frequencies in Band III by the Postmaster-General. The vision transmitters are rated at 7½/10 kW output power, while their sound counterparts are of 2/2½ kW output. Delivery is expected in the latter half of 1956. These transmitters will be capable of handling colour television programmes, although there is, of course, no indication that the B.B.C. proposes to use them for this purpose.

Devon County Show Award

Workman, Reed & Co., Ltd., Hewish, near Bristol, have won the implement gold medal awarded by the Devon County Agricultural Society at Exeter for their 1955 model diesel fully automatic electric generating set.

Telcon in South Africa

As a result of the growing demand in South Africa for special types of electric cable for use by the mines, Post Office, railways, municipalities and other industries, the Telegraph Construction & Maintenance Co., Ltd., London, has, through its subsidiary company, Telcon Africa (Pty.), Ltd., established a new factory at Wadeville, Germiston, Transvaal. The factory was recently opened by Mr. J. N. Dean, chairman of Telcon, who flew out specially for the purpose, accompanied by Mr. B. H. Musgrave, director, and Mr. C. L. G. Fairfield, general sales manager. The site of the new factory, covering approximately 6 acres, allows for future developments. It includes a research laboratory and test department, which is equipped with the most comprehensive and up-to-date apparatus. Initial manufacture will be restricted mainly to the production of thermoplastic insulated cable.

Mr. J. N. Dean (right), chairman of Telcon, showing the Mayor of Germiston, Transvaal, the plant at the official opening of the new factory at Wadeville of Telcon Africa (Pty.), Ltd. On the left is Mr. L. H. H. Young, managing director

Census of Production for 1956

The Census of Production to be taken in 1957 for the year 1956 will be a simplified census taken on a sample basis, similar to the census for 1955. This decision has been made after consultation with the Census of Production Advisory Committee and is in accordance with the programme of censuses recommended by the Verdon Smith Committee on the Censuses of Production and Distribution. The statutory form of return for the larger establishments will be a simplified one and the questions to be covered will be identical to those asked for the 1955 census. Smaller firms with fewer than eleven employees will be required to state only the nature of their business and the number of persons employed, except in a few trades in which, because of their importance, they will be asked a few additional questions, as for the census for 1955. The trades covered by the 1956 census will be the same as those included in the 1955 census, i.e., mining and quarrying, the manufacturing trades, building and contracting, and gas, electricity and water. The method of sampling will be similar to that used for the 1955 census. A stratified sample will be selected for each trade or group of trades, the sampling fractions being varied according to the number of establishments in the trade and their size distribution. Only a proportion of establishments, as in 1955, therefore, will be required to make returns. Firms that are

selected for inclusion in the sample will be notified during next autumn; they will be sent an advance copy of the form to enable them to arrange their records accordingly.

Finnish-British Trade Association

United Kingdom firms engaged in trade with Finland may be interested to know that the Finnish-British Trade Association in Helsinki has been re-formed recently. The Association was founded in 1932 with the object of encouraging and assisting trade in both directions between the United Kingdom and Finland. After 1939 the Association remained dormant, but in March last a new board was elected under the chairmanship of Mr. Holgar Nysten (manager, Finnish Paper Mills Association). Leading Finnish banking, commercial and industrial interests are represented on this board. Their first task will be to obtain a membership representative of all Anglo-Finnish trade interests. The Commercial Secretary, British Embassy, 18, Etela Esplanadikatu (6th Floor), Helsinki, would be pleased to supply further details, or to put United Kingdom firms and organizations in touch with the Association.

E.D.A. Public Speaking Competition

For the second year running the North Western Electricity Board won the custody of the women's Faraday silver challenge shield in the national final of the Electrical Development Association's public speaking competition, which was held at the Connaught Rooms on 11th May. The men's shield was won by the South of Scotland Electricity Board. Eight men and eight women, all of whom had previously won their area contests, participated in the national finals.

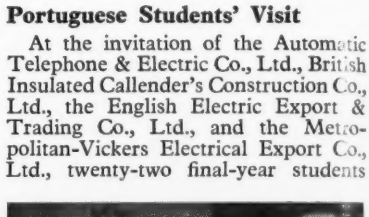
The winner of the women's shield was Miss Norma M. Thornthwaite, service centre assistant in the Carlisle district, who spoke on "The Social Influence of Electricity." The runner-up was Miss Audrey W. Milan, service centre assistant, Doncaster district, Yorkshire Electricity Board, who also spoke on this subject. Third place went to Miss Andrena R. Brown, demonstrator, Dumbarton district, South of Scotland Electricity Board, who spoke on "Lighting and Living." The other five Board contestants were:—Mrs. Linda Blease (Merseyside and North Wales), Miss Moya M. Coppock (North Eastern), Miss Pamela Jenkins (Southern), Miss Janet M. Hughes (Midlands) and Miss Jean M. Padfield (Eastern).

The judges for the women's section were Miss Shaw MacKenzie (E.A.W.), Mr. Lionel Marsden (B.B.C.), Mr. B. J. Ross (City of London School) and Mr. Geoffrey Sumner (a film producer). Mr. J. A. Stedman (education officer, E.D.A.) was in the chair and presented the shield to the winner.

Mr. J. A. Brydon Maben, who spoke on "Lighting and Living," was the men's section winner. Although he took up an appointment a few days ago as a commercial assistant in the Ripon district of the North Eastern Electricity Board, Mr. Maben was representing the South of Scotland Electricity Board (where he was formerly employed at Galashiels). Second place went to Mr. C. J. White (assistant secretary, South Eastern Electricity Consultative Council, Hove), who chose "Advertising" as the subject of his speech. Mr. K. A. Anders (sales representative, Clitheroe district, North Western Electricity Board), who also spoke on "Advertising," gained third place. Also taking part in the contest were:—Mr. J. Nimmo (North Eastern), Mr. B. A. Ward (Eastern), Mr. Francis R. Williams (Yorkshire), Mr. R. G. Charlton (South Western) and Mr. K. D. Brown (Merseyside and North Wales). Mr. R. E. Gamlen, commercial section head, South Eastern Electricity Board, was in the chair, with Miss V. Norvick (E.A.W.), Mr. Frank Phillips (B.B.C.), Mr. J. P. Stephenson (City of London School) and Mr. H. Purcell, the playwright, acting as adjudicators.

Portuguese Students' Visit

At the invitation of the Automatic Telephone & Electric Co., Ltd., British Insulated Callender's Construction Co., Ltd., the English Electric Export & Trading Co., Ltd., and the Metropolitan-Vickers Electrical Export Co., Ltd., twenty-two final-year students



At the reception given to Portuguese students showing Senhor Antonio Bento Mendes, commercial attaché at the Portuguese Embassy in London, in company with Mr. C. S. L. Wilson (left) and Mr. H. H. Jones, Metropolitan-Vickers (centre)

from the Instituto Superior Tecnico, Lisbon, and the Faculty of Oporto, accompanied by Professor Carlos Afonso de Castro Carvalho, recently visited Great Britain. They were welcomed on arrival by Mr. C. S. L. Wilson—on behalf of the companies concerned—and were entertained to dinner.

During their tour they visited the English Electric works at Rugby and Stafford; the Metropolitan-Vickers

Winners of the E.D.A. Public Speaking Competition. Ladies' section (left to right): Miss Norma M. Thornthwaite (first), Miss Andrena R. Brown (third) and Miss Audrey W. Milan (second). Men's section (left to right): Mr. J. A. B. Maben (first), Mr. K. A. Anders (third) and Mr. C. J. White (second)

works at Trafford Park; the copper refinery and factory of British Insulated Callender's Cables at Prescot; the Automatic Telephone & Electric Co.'s works at Liverpool, and Marconi's Wireless Telegraph Co.'s factories and the Marconi College at Chelmsford. In addition the students were shown the G.P.O. underground railway, the overseas and Continental telephone exchanges in London, and power stations of the Central Electricity Authority at Liverpool (Clarence Dock) and at Stourport. The cultural side was not overlooked. During a visit to Cambridge, the students toured the University laboratories and several of the colleges; at Chester they saw the Roman walls and other remains; and in London visited the Sadler's Wells Ballet at the Royal Opera House, Covent Garden.

New G.E.C. Ipswich Premises

Mr. C. T. Melling, chairman of the Eastern Electricity Board, recently opened Magnet House, the new branch premises of the General Electric Co., Ltd., in Whitehouse Road, Ipswich. With him were the Mayor of Ipswich, Mr. Leslie Gamage, vice-chairman and joint managing director of the company, and many friends of the G.E.C. in the area. The new building is twice as large as the premises in Ipswich which it replaces and has much improved showroom, stockroom and service facilities. The branch has a staff of fifty-five under the management of Mr. A. White.

The new building was designed by the company's constructional engineer's department, Wembley, the general contractors being Sadler & Son, Ipswich, the sub-contractors for structural steelwork, Boulton & Paul, Ltd., and the electrical sub-contractors, E. H. Ruddock, Ltd., of Brightlingsea.

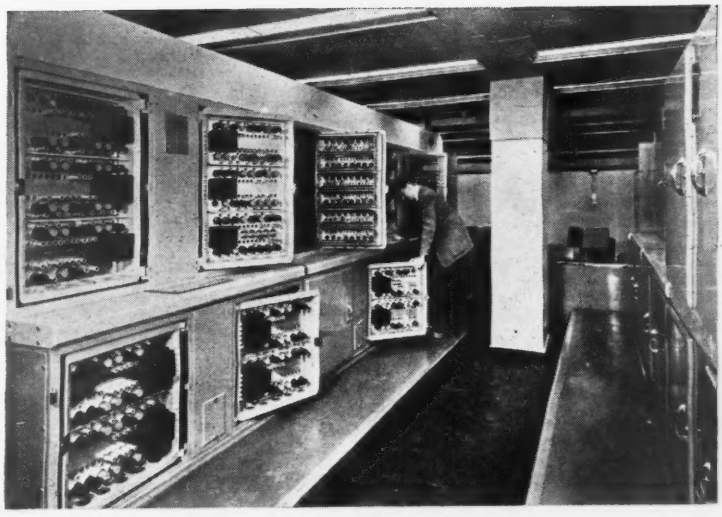
Silicones Exhibition

An exhibition of the history, production and application of silicones is to be held by Midland Silicones, Ltd., at the Midland Hotel, Manchester, from 13th to 18th June. In addition to a display of working exhibits a number of films will be shown. Invitations to the exhibition can be obtained from the company, 19, Upper Brook Street, London, W.1.

Computer for Oil Group

One of the largest electronic computers in Western Europe, nicknamed "Miracle," has just come into use at the Amsterdam Laboratory of the Royal Dutch/Shell Group of oil companies. Built by Ferranti, Ltd., it was installed at a cost of nearly £250,000. "Miracle" contains some 4,000 radio valves, 2,500 capacitors, 15,000 resistors, 6 miles of wire and 100,000 soldered joints.

The computer will broaden the laboratory's field of activities, in some aspects hampered in the past by the impossibility of carrying out very complex calculations within a reasonable period. It will be used to solve problems in all phases of fundamental and technical research. For example, in the development of a new refining or chemical process, extensive experiments are required in order to determine the effect of a great many variations on it, on the properties of its products, and hence the best process conditions. In the course of such an investigation samples of the product are taken at regular intervals and their composition has to be determined as quickly as possible. This is done with instruments which give readings from which the percentages of the various components can be worked out. As there may be twenty or more components involved there arises the task of solving twenty or more equations with the same number of unknown factors. Their solution by normal means might take days; "Miracle" will do the job in a matter of minutes.



Ferranti computer installed in Amsterdam

Works Visit

On 9th May delegates attending the Commonwealth Telecommunications Board, and was entertained to lunch in London paid a visit to the new Ocean Works of Submarine Cables, Ltd., where the first transatlantic telephone cables are being made. The party was headed by Colonel Sir A. Stanley Angwin, chairman of the Board, and was entertained to lunch at Telcon Works, Greenwich, by Mr. J. N. Dean, chairman and managing director of Submarine Cables, Ltd., and his co-directors.

Annual Holidays

The works of Holophane, Ltd., Elverton Street, Westminster, London, S.W.1, will be closed for the annual holidays from 18th June to 2nd July. The office will remain open, but during the period no deliveries will be made.

The following are the summer holiday arrangements of the works of British Insulated Callender's Cables, Ltd.:—Prescot, Helsby, Melling and Huyton Quarry: Closed from 22nd July to 6th August. Willenhall Foundry: Closed from 23rd July to 6th August. Erith: Closed from 16th July to 1st August. Anchor Works, Leigh: Closed from 2nd to 9th July and 10th to 17th September.

The Handsworth works of the Northern Aluminium Co., Ltd., will be closed from 23rd July to 7th August, and the Banbury and Rogerstone works from 29th July to 15th August and 23rd July to 7th August respectively.

Building Plant Exhibition

A building plant exhibition organized by the Ministry of Works will be held from 8th to 15th June on the Queenslie Industrial Estate, Glasgow. Equipment to be shown will include portable powered tools, generators, floodlamps, fork-lift trucks, cranes, hoists and winches.

Morden Milk Centre

Referring to the article on this Centre which appeared in our issue of 6th May, the Watford Electric & Manufacturing Co., Ltd., points out that the bottom illustration on page 794 shows an automatic starter switchboard which that company supplied, as well as the main switchboard with Ellison circuit-breakers.

Change of Name

Northern Lights (Cricklewood), Ltd., has changed its name to Northern Lights (1946), Ltd.

Trade Announcements

Hirst Electronic Development, Ltd., has removed to Gatwick Road, Crawley, Sussex.

A new depot was opened by **Johnson & Phillips, Ltd.,** on 16th May, at Spital House, Spital Hill, Sheffield, 4 (telephone: Sheffield 22893), in the charge of Mr. P. C. Dougherty.

Diesel-Electric Shunting Locomotives

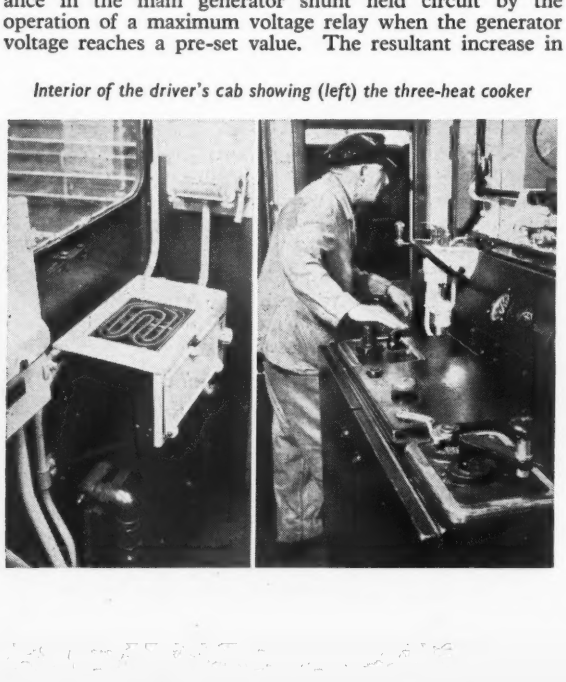
FIFTEEN power equipments for standard 350 h.p. diesel-electric shunting locomotives were ordered from the General Electric Co., Ltd., in the British Railways 1954 building programme, and locomotives with these equipments are now going into service. This standard locomotive design has the 0-6-0 wheel arrangement, the outer axles being driven through double-reduction gearing by axle-hung traction motors.

The power equipment consists of a 350 h.p. Lister Blackstone E.R.6T (traction) 6-cylinder diesel engine driving a G.E.C. single-bearing traction generator, an auxiliary generator (also G.E.C.) and Keith Blackman traction motor blower being driven by V-belts from the main generator shaft. The whole unit is mounted on a resilient three-point suspension. The continuous ratings of the locomotives are:—Series connection, 15,000 lb at 4·6 m.p.h.; parallel connection, 12,000 lb at 8·2 m.p.h. Tractive efforts up to the adhesion limit can be developed at low speeds. The single-acting, four-stroke vertical type diesel engine, built as a totally-enclosed, water-cooled unit, develops 350 h.p. at 750 r.p.m.

The main generator is continuously rated at 550 A, 410 V, at 750 r.p.m. It is self-ventilated, cooling air being drawn in through the filter panels in the sides of the locomotive and exhausted into the engine compartment to provide combustion air and also create a slight pressure in the engine compartment, which retards the ingress of dirt. The two forced-ventilated traction motors are nose-suspended and are each continuously rated at 140 h.p., 360 V, 320 A.

The locomotive is controlled by first increasing the excitation of the main generator with the engine running at 350 r.p.m., and then accelerating the engine to its full speed of 750 r.p.m. The controller handles on the driver's desk are duplicated to enable the locomotive to be driven from either side of the cab. Both handles are geared to a horizontal cam type controller with silver butt contacts. When the controller is moved from notch 1 to notch 2, resistance is cut out of the main generator separately-excited field circuit in eight steps. Continuing from notch 2 to notch 3 the diesel engine is accelerated continuously to its maximum speed by means of a mechanical linkage to an oil servo device which regulates the compression of the governor spring. When the controller is moved to notch 4, a circuit is prepared for cutting out the single step of resistance in the main generator shunt field circuit by the operation of a maximum voltage relay when the generator voltage reaches a pre-set value. The resultant increase in excitation gives greater tractive effort at higher speeds.

Interior of the driver's cab showing (left) the three-heat cooker



In addition to the automatic protective devices an emergency stop button is provided which interrupts the feed to the control circuits and de-energizes the valve through which oil is fed to the servo-cylinder of the fuel pump rack operating mechanism. Thus the locomotive power equipment is completely shut down.

Provision is made for starting the diesel engine by towing or pushing the locomotive if the generator cannot be motored from the battery. In these circumstances one traction motor is used as a generator, connected to the starting field of the main generator by operation of the road start switch. An operating rod is housed inside the driving desk to enable one of the main contactors to be closed by hand. Links enabling either traction motor to be isolated in case of failure are also accessible when the desk is opened.

Deadman's pedals are provided on both sides of the cab, and their action is delayed by about 5 sec to enable the driver to cross the cab as necessary for observing shunters' signals. A sloping panel at the back of the desk carries the battery ammeter, duplex air gauge, water temperature indicator and lubricating oil pressure gauge. The main ammeter and "Circscale" electric speedometer are mounted on a bracket which is adjustable for easy observation from either side of the cab.

The belt-driven 8 kW auxiliary generator provides a supply at 92 V for the main generator separately-excited field, the compressor, exhauster, driver's 3-heat cooker, and for charging the 40-cell, 108 Ah battery. Lighting circuits, including marker lights at both ends of the locomotive, are connected across the battery, which is on floating charge while the engine is running; or the lights can be operated from the battery alone when the engine is stopped. Provision is made for self-excitation of the auxiliary generator if the battery has to be isolated for any reason.

A Westinghouse D.H.16 motor-driven compressor is carried under the main frame forward of the leading axle and a Westinghouse three-cylinder exhauster on the running plate; the G.E.C. motor driving the latter has a tapped field to provide running speeds of 600 and 1,200 r.p.m.

I.E.E. SOUTHERN CENTRE

THE summer meeting of the Southern Centre of the Institution of Electrical Engineers will take place on 17th June at Hampton Court. After lunch a visit will be paid to the works of the Hackbridge & Hewittic Electric Co., Ltd., Walton-on-Thames. The party will return to Hampton Court for tea. Coaches for the trip will leave Brighton, Portsmouth and Southampton. The cost for members and guests (including ladies) will be 17s 6d each and for students and guests 15s. Applications for reservations must be made by 6th June.

The Centre is holding an open golf competition and prize draw at Stoneham Golf Club on 21st June in aid of the I.E.E. Benevolent Fund. Entry forms are available from Mr. G. D. Arden, "Little Farne," Cliffe Road, Barton-on-Sea, Hants.

I.E.E. Annual Report

THE annual report of the Institution of Electrical Engineers for 1954-1955 which was presented at the 83rd annual general meeting of the Institution on 19th May says that the rate of growth of membership has been maintained at the level noted in previous reports, but is still insufficient in view of the national need for adequate numbers of professionally qualified electrical engineers. Of the young men who decide to make electrical engineering their career, the proportion who join the Institution at an early age, before becoming corporate members, is too low. This is a separate problem, and it arises from a variety of reasons which are being actively studied.

During the year discussions continued with the Minister of Education and the National Advisory Council on Education for Industry and Commerce. In the result much misgiving is felt at the Minister's reluctance to accept the advice offered by the three engineering institutions on the future development of technological education, and the presidents of the three institutions have recently written to the Minister emphasizing the views of the institutions.

Because of the current shortage of electrical engineering textbooks, a Technical Publications Panel has been formed with the object of encouraging the publication of textbooks, particularly those of post-graduate standard. Authority has been given for the establishment of an "Institution Series" of textbooks.

The introduction of works-based sandwich diploma courses has been welcomed by industry. A new scholarship for students pursuing these courses has been introduced and will be known as "The Arthur Fleming Scholarship" to commemorate Sir Arthur Fleming's lifelong interest in the education and training of persons employed in the electrical engineering industry.

In the Institution examination, the former Section A has been replaced by the new Part I. Under the revised arrangements for the conduct of Part I and the participation of the Institution of Mechanical Engineers, the three engineering institutions are now equal partners in the scheme; provision has been made in the terms of reference of the controlling committee for the admission of other engineering societies.

Nuclear Energy Conference

Discussions are in progress with a number of other learned societies for the establishment of a "British Nuclear Energy Conference" which will co-ordinate the work of the supporting societies in the field of nuclear energy and provide a channel for the dissemination of technological information regarding development of nuclear energy in Great Britain.

The publication arrangements for the *Journal* and the *Proceedings* of the Institution were reviewed and a number of alterations decided upon.

The number of members of the Institution elected during the year was 2,200 compared with 2,400 in 1953-54 and the Membership Committee dealt with 2,174 other applications, mostly for transfer from one class to another, making a total of 4,374. On 1st April last there were 31,148 corporate members and graduates on the register, representing 79·3 per cent of the total membership of 39,298. For the first time the total number of corporate members exceeded 20,000. The number of graduates increased to 11,153 (10,717 in 1954). Nearly 200 candidates attended for interview by representatives of the Council and thus were enabled to explain personally the degree of responsibility which they were undertaking. The Council decided that the fee of £4 previously charged to such candidates should be abolished as from 1st January last.

The Council elected Mr. J. R. Beard (past-president) to honorary membership of the Institution, for his distinguished services to the profession, and the Duke of Edinburgh, for the interest which His Royal Highness has long displayed in science and engineering. The thirty-third award of the Faraday Medal was made to Sir John Cockcroft, director of the Atomic Energy Research Establishment, Harwell, for the conspicuous services he has rendered to the advancement of electrical science.

During the year 1,292 meetings of the members, the Council and the various committees were held in London and at the local centres. Twelve ordinary meetings were held in London, with an average attendance of 314 as compared with 256 for the previous year. A joint meeting with the Institution of Civil Engineers, three extra meetings, and the annual general meeting were also held. A public meeting was held at the Central Hall, Westminster, London, for the delivery of the 1954-55 Faraday Lecture by Mr. T. B. D. Terroni. The 45th Kelvin Lecture on "The Physics of the Ionosphere" was given by Mr. J. A. Ratcliffe.

The Council is at present reviewing the scope of the specialized sections, paying particular attention to the organization of the light current and radio fields and taking into account the fields covered by the technical committees on electrochemistry and electrometallurgy, telegraphs and telephones, and traction. The membership of the sections continues to grow; particulars of this growth and of the activities of the sections are summarized below.

	Membership at 31st March, 1955	Number of meetings	Average attendance (figures for last year in brackets)
Measurements Section ...	2,442	14	65 (87)
Radio Section	5,037	17	134 (165)
Supply Section	4,328	10	157 (139)
Utilization Section	4,149	8	112 (95)

Informal meetings continue to play an important part in the activities of the Institution and the keen interest of members in the wide variety of subjects discussed has been evidenced by the good attendance at the six meetings held. As their title implies, the proceedings at these meetings are entirely informal, and no reports are published in the *Proceedings*.

On 1st January, 1955, 17,381 members were attached to the ten local centres as follows:—East Midland, 1,118; Merseyside and North Wales, 1,232; North-Eastern, 1,304; Northern Ireland, 274; North Midland, 1,799; North-Western, 2,888; Scottish, 1,707; South Midland, 3,317; Southern, 1,533; and Western, 2,209.

District meetings in increasing numbers have been held throughout the country wherever membership of the Institution is too scattered to justify the provision of more formal local activities. The informality of this type of meeting is undoubtedly a great attraction and it is true to say that many members who otherwise would have had little opportunity of attending a meeting of the Institution have been able to take part in the discussion of Institution papers.

Although, as already noted, the membership of the students' sections has again fallen, there is no evidence that this has resulted in a further decline in attendances

at meetings, as compared with the previous year. In fact, there has been encouraging support for a number of meetings, particularly the students' lectures delivered by Dr. E. C. Cherry on "Communication of Information—Human, Animal and Machine," and Mr. A. R. Cooper on "Attitudes of Mind." A feature of both these lectures has been the excellent discussions to which they have given rise. The *Students' Quarterly Journal* has been maintained at its recently increased size of 64 pages.

The activities of the overseas branches and committees have been maintained, and so far as local conditions would allow meetings, visits and social functions have been arranged for the interest of local members. Several senior members, who have had to travel abroad, have addressed meetings of members and have thereby strengthened the links between the Institution at home and members overseas. A number of overseas members have called at headquarters during the year, some 150 having signed the overseas register.

The attendance at the annual dinner each year continues to increase and a record total of almost 1,400 members and guests attended the function this year which was held at Grosvenor House, London, on 24th February. The 1954 summer meeting of the Institution held in the area of the Western Centre was attended by 257 members and ladies. This year's summer meeting, at the invitation of the chairman and committee of the Scottish Centre, is being held in the Highlands from 6th to 11th June.

The new Codes of Practice Council has set up a Codes of Practice Committee for Electrical Engineering under the chairmanship of Mr. P. V. Hunter, the secretariat for which is provided jointly by the British Standards Institution and the I.E.E. The existing code drafting committees now report to this Committee and their secretariat servicing is shared between the I.E.E. and the British Standards Institution as previously, the I.E.E. retaining responsibility for all the electrical codes for buildings. Codes dealing with radio interference abatement are also referred to.

Close collaboration has continued between the I.E.E., the Institution of Civil Engineers and the Institution of Mechanical Engineers in order to ensure effective co-operation in matters of common interest to their members. The work of the British Council has continued to receive support, in particular through the service of Mr. T. G. N. Haldane, past-president, on its Science Advisory Committee, and of the secretary on its Science and Engineering Panel. Association with the work of the British Standards Institution has also been maintained.

The support of the Institution for the work of the British Electrical and Allied Industries Research Association continues. Professor J. Greig and Mr. A. W. Montgomery serve on its Council as the nominees of the Council of the Institution. Four members of the British National Committee of the I.E.C. are nominated by the Council, and are chosen so that the aspects of illumination and telecommunication, as well as electrical engineering generally, are represented.

Discussions with Sir Ronald Weeks and members of the National Advisory Council on Education for Industry and Commerce, at the request of the Minister of Education, led to the preparation of a document by the Institutions which set out a scheme which the Institutions would be prepared to support in an effort to bridge the gap between their recommendations and those of the National Advisory Council. The latter considered this document and presented to the Institutions their further views which proved wholly unacceptable as they still revealed major differences of principle between the two. Further reconciliation between the two points of view appeared to be impossible and the new Minister of Education was faced with a serious gap between the maximum compromise on the part of the Institutions and the views held by the National Advisory Council.

A second conference on courses for electrical technicians was held in July, 1954, to consider proposals for a basic course for electrical technicians together with detailed syllabuses for the first three years of a five-year course. These proposals formed the interim report of a committee which was set up by the Council to study the general pattern which technician courses might follow and to prepare syllabuses covering basic education and specialized applications. A request that the Council should undertake this work was made at an earlier conference on technicians which was held in June, 1953. More than 50 delegates attended the second Conference, including representatives of the Ministry of Education, Regional Advisory Councils for Further Education, the B.E.A.M.A., the Radio Industry Council, and the City and Guilds of London Institute.

Year to 31st March	Corporate members	Non-corporate members	Total membership	Annual increase
1941	10,121	10,154	20,275	403
1942	10,483	10,483	21,050	775
1943	11,097	11,218	22,315	1,265
1944	11,924	12,634	24,558	2,243
1945	12,573	14,091	26,665	2,107
1946	13,447	15,711	29,158	2,493
1947	14,501	16,759	31,260	2,102
1948	15,206	17,701	32,907	1,647
1949	16,027	18,344	34,371	1,464
1950	16,648	18,900	35,548	1,177
1951	17,146	19,412	36,558	1,010
1952	17,757	19,496	37,253	695
1953	18,510	19,272	37,782	529
1954	19,552	18,944	38,496	714
1955	20,355	18,943	39,298	802

The table shows the growth of membership over the last fifteen years.

A.P.L.E. Conference

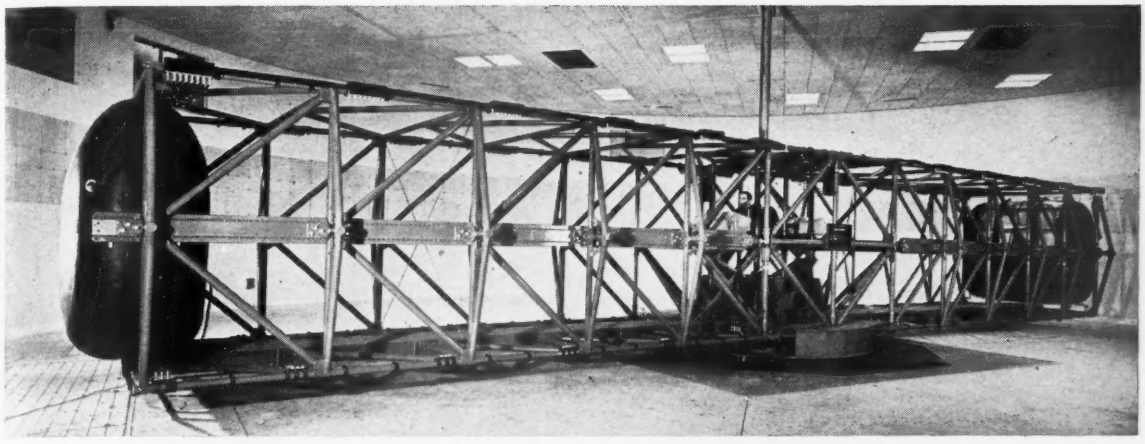
THE annual conference of the Association of Public Lighting Engineers is to be held this year at Folkestone, from 13th to 16th September inclusive, and conference sessions will be held in the Leas Cliff Hall. In addition to four papers on public lighting there will be a comprehensive exhibition of street lighting apparatus and equipment, together with an outside display of lamp columns and tower wagons. The exhibition and outdoor display will take place on a site in Langhorne Gardens opposite the conference hall.

On the first day there will be an official welcome by the Mayor of Folkestone, Councillor T. L. E. Franks. This will be followed by the induction of the president, Mr. J. M. Waldram, who will give his presidential address, after which the Mayor will open the exhibition and outdoor display. In the afternoon, Messrs. G. Berry and W. H. Shaw will give a paper on "Local Authorities and Public Lighting," and in the evening there will be a reception by the Mayor and Mayoress.

On the second day, after an inspection of the exhibition and the outdoor display, the annual luncheon will be held at the Hotel Metropole, and in the afternoon visits will be paid to Silver City Airways (Ferryfield Airport), the Dover Harbour Board's new car ferry terminal, and Dover Castle.

The third day's proceedings will open with a paper by Dr. J. W. T. Walsh on "The Code of Practice for the Lighting of Roads other than Traffic Routes," and this will be followed in the afternoon by a paper on "The Lighting of Tree-Lined Roads," by Messrs. H. M. Ferguson and W. R. Stevens. In the evening Mr. and Mrs. Waldram will hold a reception. On the final day Mr. J. F. McKenzie will give a paper on "The Centralized Control of Street Lighting," and the conference will close with an address by the president.

A mannequin parade and a coach tour have been arranged for ladies attending the conference.



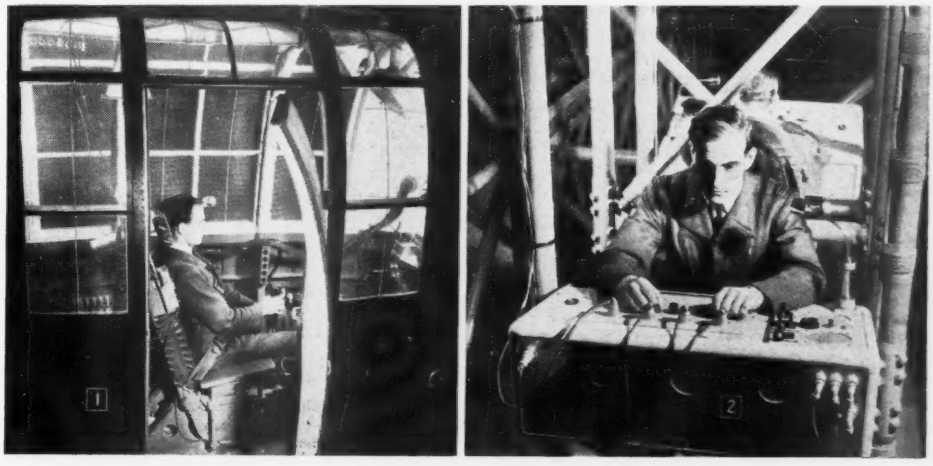
Man-Carrying Centrifuge

NEW INSTALLATION AT THE R.A.F. INSTITUTE OF AVIATION MEDICINE, FARNBOROUGH

ON Tuesday this week Lord Thurso, a former Secretary of State for Air, officially inaugurated at the R.A.F. Institute of Aviation Medicine at Farnborough, Hampshire, a vast and complex equipment known as a man-carrying centrifuge which is capable of simulating the centrifugal acceleration encountered by pilots when they change direction at high speed. The equipment consists essentially of a horizontal rotating arm structure about 60ft long, with a man cabin at each end. In operation the speed of the arm can be accelerated to an extent whereby the centrifugal force at the cabins can be as high as thirty times the force of gravity, although 10 "g" is the maximum force to which men will be subjected. In this way it will be possible to obtain much information relating to the conditions under which a pilot's blood tends to "pool" in the lower parts of the body, and when he suffers from fatigue, impairment of muscular functions, "black-out," etc.

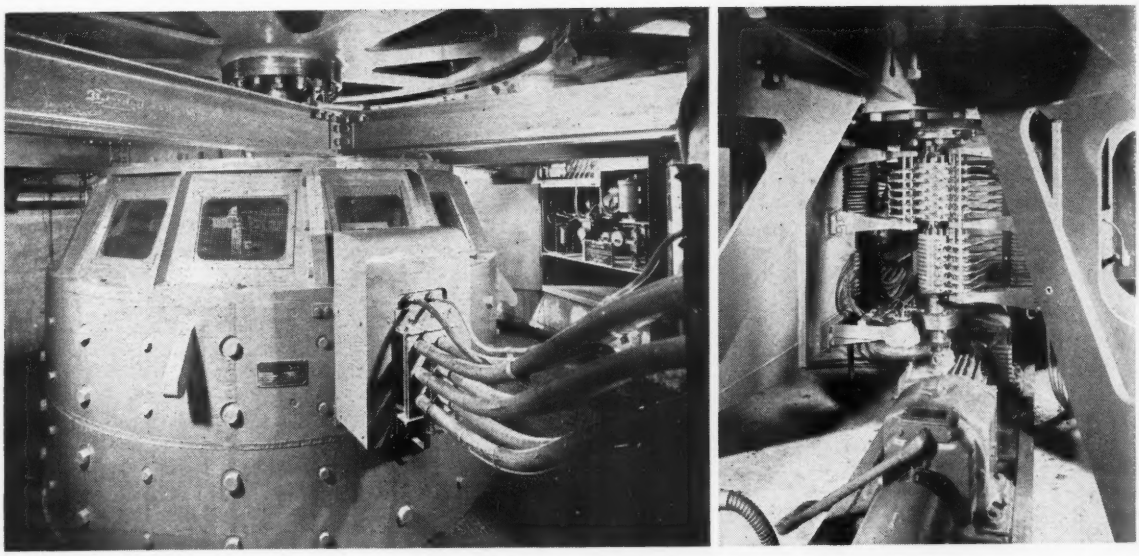
The equipment is essentially electrical. It is directly driven by a d.c. motor housed below floor level under the centre of the arm, while the reactions of the subject, i.e., the man in the cabin, such as pulse and respiration rates, blood pressure and heart and brain functions, are recorded electrically from electrodes attached to his body, the wires being run from the car, along the arm, up through a hollow shaft in the centre of the arm which extends to a slip-ring column in the roof near the recording room. Reactions are indicated either as curves photographed in a camera-recorder, or as graphs drawn by a pen-recorder. The pen-recorder is so sensitive that the minute currents generated by the subject's brain or by moving his eyes can be measured. This extreme sensitivity makes recording a very difficult operation, as small outside electrical influences can easily spoil the records. For example, stretching a piece of elastic, or combing the hair near the subject, can cause the recording-pen to move right off the paper chart.

For this reason all the conducting wires are screened by a flexible earthed metal sheath. Many of the rooms in the building above are completely screened by copper mesh over the walls, floors and ceilings while the doors are covered with sheet copper. The rate of acceleration of the cars or the subjects is governed by the speed of the motor and the effective radius of the arm; so that the rate of change of acceleration is controlled by the rate of change of the motor speed. Each car is mounted on trunnions, fore



1. The physiological reactions of the subject in a cabin are transmitted to instruments in the recording station of the medical laboratory, and he has facilities for speaking to the controller

2. "Teletalk" apparatus enables the observers at the centre of the centrifuge to speak to the controller, recorder and the subject



The vertical spindle d.c. driving motor is disposed centrally under the centrifuge. Right: The extension shaft beneath the driving motor carries 24 slip-rings for circuits to the rotating structure, for control purposes and for lighting and experimental use

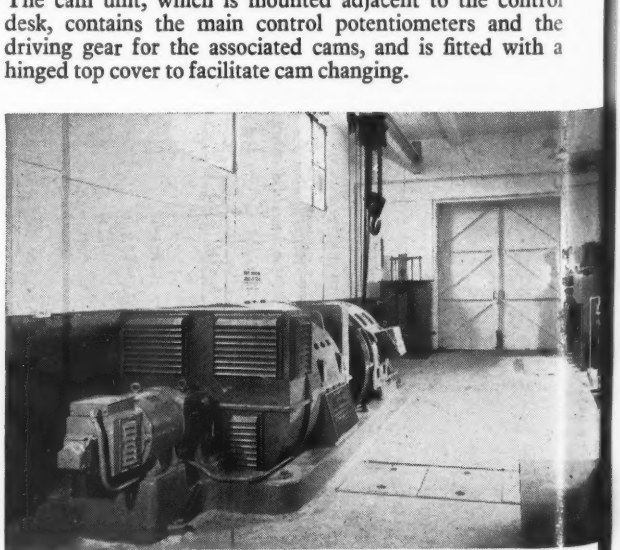
and aft, so that it can swing out to maintain the direction of the resultant acceleration on the subject unchanged as the centrifuge speeds up. Hydraulic dampers are provided to check any tendency of the cars to overswing or oscillate. The speed of the motor is varied, in accordance with the programme required, by the electrical control gear, while the arm is provided with a number of attachment points for the cars, so that alternative radii can be selected. At the maximum motor speed of 54 r.p.m. and the full radius of the arm the maximum centrifugal force of 30 " g " is obtained.

The centrifuge can be operated either automatically or manually by a " controller " seated at his desk in the control room, or by either of the two " subjects " in the cars. When the two " subjects " are jointly controlling the speed, the mechanism is so arranged that the speed automatically follows the lower setting, while in an emergency the arm can be brought to rest by the " controller," by the " subjects " or by " observers " seated at the centre of the arm on either side of the driving spindle. The observers travel round with the centrifuge and have a clear view of the " subjects " through the " Perspex " roofs of the cars.

The main driving motor is a vertical spindle d.c. machine having an overall weight of 46 tons; it is supported on a stool which houses an extension shaft carrying a group of 24 slip-rings for providing circuits to the rotating structure for control purposes, lighting and experimental use. The connecting cables pass through the hollow shaft of the motor up to the arm. Half of the slip-rings are rated at 60 A and the remainder at 30 A. The motor is fitted with a 12in diameter ball thrust bearing of the angular contact type, and with a top roller guide bearing 17½in in diameter. The motor is rated at 1,350 h.p. at 54 r.p.m. A gearbox with a ratio of 3:43 is directly coupled to the motor shaft extension below the slip-rings, and the high-speed shaft of the gearbox drives two tacho-generators and three overspeed devices. Two " magslip " transmitters are also driven from the motor shaft extension through 2:1 reduction gears.

A separate slip-ring column is mounted above the arm in a room over the centrifuge chamber. This column is directly coupled to the arm and is fitted with 60 silver slip-rings and 30 mercury troughs for the various electro-medical and teletalk circuits. The slip-rings are divided into three banks of 20 rings, and the mercury troughs into five banks of six troughs arranged in pancake form. Two silver-carbon brushes are provided for each slip-ring, and there is a spade-type collector for each mercury trough.

The control desk, the amplifier for the teletalk equipment and a cam unit which controls the cycle of acceleration and deceleration, are housed in a control room which has a window which gives the " controller " a clear view of the rotating arm in the centrifuge chamber. The " controller's " joystick is mounted in front of the desk, which consists of two wings joined by a centre section. The centre portion of the desk is equipped with a motor speed indicator and a " g " meter showing the acceleration to which the men in the cabins are subjected; the wings house the various control switches, instruments and relays and also the control equipment for the teletalk apparatus. The cam unit, which is mounted adjacent to the control desk, contains the main control potentiometers and the driving gear for the associated cams, and is fitted with a hinged top cover to facilitate cam changing.



G.E.C. main control board and motor generator set

The main control cubicle contains the contactors, relays and general protective equipment, in addition to the electronic apparatus. It is housed in a plant room which also accommodates a motor generator set which supplies power to the main driving motor on the Ward-Leonard control principle.

The m.g. set consists of a 1,950 kW 760 V d.c. generator, driven at 980 r.p.m. by a 1,250 h.p. induction motor, and an exciter serving the field windings of the centrifuge motor.

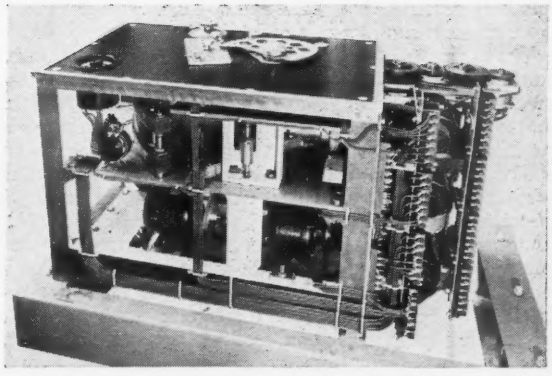
The armature of the centrifuge motor is energized by the generator of the main m.g. set, and the field by the constant-voltage exciter. Variation of the speed of the centrifuge motor is achieved by adjusting the excitation of the m.g. set generator, and hence the voltage applied to the armature. This automatic adjustment is made under electronic control.

Two separate signals are fed to the input stage of the electronic equipment. The first of these is derived from tachogenerators which are geared to the centrifuge motor and thus develop a voltage proportional to the instantaneous speed of the arm. Two tachogenerators are employed as a safety precaution, and a differential relay connected across them initiates a shut-down in the event of any inequality between the two systems. The second signal is derived from the cam unit, and is proportional to the desired instantaneous speed. The difference between the signals represents the instantaneous speed error, and constitutes the actuating signal to the input unit of the electronic equipment. From this unit the error signal is passed to a two-stage valve amplifier which incorporates a stabilizing network for the control system, and hence to the control grids of a 3-phase thyratron rectifier which constitutes the output unit and is used to energize the field of the m.g. set generator. The error signal thus varies the excitation of the m.g. set generator in the appropriate sense to correct the discrepancy in motor speed which initiated the signal.

The cam unit which provides the " desired instantaneous speed " signal, consists essentially of a pair of potentiometers which are traversed by brushes attached to an arm. Movement of this arm is controlled by a programme cam or a stop cam. As in the case of the tachogenerators, two potentiometers are employed to ensure safety, and any discrepancy between the two systems will cause operation of a relay which initiates a shutdown. The potentiometers are bow-shaped and are mounted one above the other; the effective radius of the brush arm is 24in and the total travel between the low and high speed position 41½ deg. The reference voltage provided from the potentiometers varies from zero at standstill to 400 V in the high speed position. The signal fed to the electronic equipment is the difference between this and the voltage developed by the tachogenerators, and a difference of less than 1 V will result in full excitation of the generator. The arm is moved towards the high speed position by a weight to which it is attached by means of a chain passing over a pulley. The arm bears against the programme cam, which, when rotated, permits the arm to move at a rate dependent upon the profile of the cam. This cam is rotated by an induction motor through a V-belt transmission with multi-step pulleys which enable the appropriate cam speed to be pre-selected. The test cycle of the centrifuge is controlled by the profile of the programme cam, and a range of cams covering the various test requirements is provided.

The second or stop cam follows the travel of the arm in a manner such that it can take over the duty of pushing the arm towards the low speed position with the minimum of delay. The stop cam cannot be changed, and the speed at which it can move the arm to the lower speed position is fixed by safety considerations. It is brought into action only on failure of the programme cam, on remote stopping, or when the overall time limit has expired. The stop cam is driven by a d.c. motor. The cam unit includes a series of interlocks to ensure the correct orientation of the cams, and their return to the low speed position for starting. The cam unit is also provided with a series of " g plates," one of which must be inserted before the apparatus can be used. Each plate acts as a definite stop to the travel of the brush arm, and thus limits the maximum speed which the centrifuge can attain to a predetermined value. Plates with stops at 10 g, 15 g, 20 g, and 30 g, are provided.

The control equipment provides facilities for two automatic systems and one manual system of programme control. The automatic system provides a complete programme of acceleration and retardation from start to stop. The " controller " may take over control of the arm by operating the manual/auto switch, but if this is done it is not possible to return to automatic control. The automatic control provides for long runs under programme control, without " subjects " present in the cars for duration tests. Under manual control the " subjects's " and " controller's " joysticks operate twin-torque transmitters through quadrants, and associated twin-torque receivers impart an equivalent movement to a follow-up drum controller. Although each joystick can be moved independently, the drum controller is so arranged that all three



The cam unit which provides the " desired instantaneous speed " signal for the man-carrying centrifuge

The control room houses the control desk, teletalk amplifier unit and the cam unit

operators must agree to raise speed, but any operator can lower speed in contradiction to the others.

The centrifuge can be " inched " into position by push-button operation on the control desk, and under these conditions the field m.g. set generator is connected to the constant voltage exciter and the electronic equipment is out of use.

The stop buttons and various trips in the stop circuit normally initiate an electrically-controlled retardation of the centrifuge. In the event of a failure of the electronic equipment, operation of an emergency stop button, or the failure of the power supply, the supply to the motor is tripped, and the arm slows down under the action of the mechanical brake. The control circuit is arranged to ensure that mechanical and electrical braking can never take place simultaneously.

The mechanical braking is hydraulic in action, and is controlled by means of valves actuated by d.c. solenoids. The brake shoes engage with the rim of the flywheel, and are spring-loaded to the " off " position. Under normal stopping conditions the brakes remain inoperative until the arm is virtually " home," when they are applied and used also as " holding " brakes.

Although the maximum speed and rate of change of speed are governed at all times by the profile of the cam in use, the control scheme incorporates a number of additional safety features which do not form part of the normal control circuit.

The design requirements were specified by the chief mechanical and electrical engineer, Air Ministry Works Directorate, to meet the functional requirements of the Institute of Aviation Medicine, and his division supervised the construction, installation and tests.

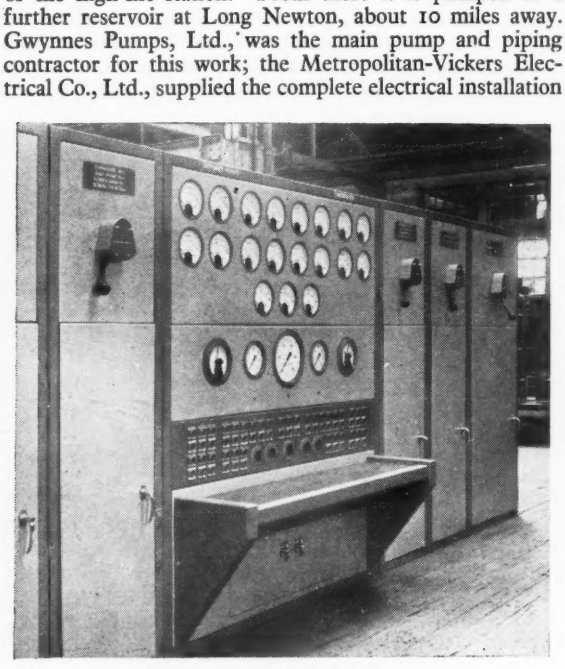
The contract for the centrifuge was placed with M. B. Wild & Co., Ltd., who acted as main contractors, and all the electrical plant and control gear was supplied by the General Electric Co., Ltd.

Acknowledgment is due to the Air Ministry for permission to photograph the centrifuge installation and to publish this description of it.

Tees Valley Pumping Station

A NEW pumping station and rapid gravity filtration works of the Tees Valley Water Board at Broken Scar, near Darlington, was recently inaugurated. It is designed to supply purified water to the whole of the Tees Valley area with the exception of Darlington itself, which is served by its own water undertaking.

There are two separate pumping stations on the site. The low-lift station pumps water from the River Tees at a maximum rate of 12 million gallons a day to a nearby reservoir. The water then flows by gravity through the various filters and chemical treatment plant, into the sump of the high-lift station. From there it is pumped to a further reservoir at Long Newton, about 10 miles away. Gwynnes Pumps, Ltd., was the main pump and piping contractor for this work; the Metropolitan-Vickers Electrical Co., Ltd., supplied the complete electrical installation embracing transformers, motors, cables, control and switchgear; and L. E. Wilson & Co., Ltd., carried out the erection and cabling to Metropolitan-Vickers requirements.



Part of the control panel, showing the control desk for the low-lift pumping station

The low-lift station is on the north bank of the River Tees, and water flows to the pumps via rotary screens driven by two-speed motors. There are six 735 r.p.m. pumps in the station, driven by quiet-running vertical squirrel cage induction motors supplied at 3·3 kV, direct-on-line started, and controlled from a multi-panel starter board with a control desk built in at the centre. There are two motors of 220 h.p., two of 185 h.p. and two of 135 h.p., one of each pair acting as a standby. The size of pump to be run at any particular time is determined by the quantity of water flowing in the river. A duplicate 3·3 kV supply is brought to the pumping station switch-room, where it is distributed by a seven-panel type KOB circuit-breaker board. A 415 V supply for lighting and auxiliary services is obtained from two 50 kVA transformers housed in a small building adjacent to the station.

The high-lift station, in addition to housing the pumps required for transporting the water to Long Newton reservoir, also contains all the filtration equipment which involves the use of a large number of small electric motors, all of which are duplicated.

There are two 840 h.p. and two 525 h.p. main pumps, driven by 980 r.p.m. horizontal slip-ring motors supplied at 3·3 kV. The 840 h.p. pump motors are controlled by stator contactors and motor-operated liquid rotor starters. The 525 h.p. pump motors can be varied in speed from 980 to 800 r.p.m. by means of push-button operated liquid rotor regulators. The pumps are controlled from two multi-panel starter boards built into one wall of the pump room. Each board has a central control desk.

The two pumping stations are fed from a substation situated near the high-lift station. A duplicate 6·4 kV supply is brought into the substation and stepped down to 3·3 kV by two 1,500 kVA transformers, operating in parallel. The 3·3 kV switchboard is a nine-panel type KOB circuit-breaker board, providing h.v. supplies to the two stations. Also housed in the substation are two 3,300/415 V 200 kVA transformers for lighting and auxiliary services in the high-lift station.

Semi-Conductors

Transistors and Associated Devices

THE discussion on the five papers on transistors and associated semi-conductor devices (see *Electrical Review*, 13th May) which were presented on 11th May at a joint meeting of the Radio and Measurements Section of the Institution of Electrical Engineers, was opened by Dr. J. R. Tillman, who referred to the difficulty of assessing noise, dealt with by Mr. Nicholl, because there was as yet no very sound theory on flicker noise. Mr. Stephenson, in dealing with noise in junction transistors, he said, adopted an analysis which was of considerable use in considering the effect of the generator impedance, but he (Dr. Tillman) did not like to see the noise generators placed in the input when there was strong reason to believe that physically much of the noise was generated at the collector.

The most curious physical point in the paper on the photo-electric cell was the extension of the long-wave cut-off. If the small spot of light was focused on the surface of the photocell by a lens of large aperture, giving a half-angle of 45 deg, the beam of light on entering the n-type germanium would have a half-angle of about 11 deg. Presumably it was focused well within one diffusion length of the junction, or say 100 microns away. The n-type germanium might be expected to be transparent to wavelengths above 1·8 μ, so that this cone of light would penetrate the n region and part of it would ultimately enter the p region, doing so before it had gone all the way through the cell, which was 800 microns deep. Possibly the transparency and high internal reflection of the n region allowed some of the infra-red above 1·8 μ to enter the p region, so that the p region was responsible for the increased sensitivity.

Dr. J. Evans remarked that Light and Hooker, dealing with d.c. convertors, required a transistor with a higher collector voltage. In their case, where a high frequency was not required, he thought that could be done by using material of high resistivity. For this application p-n-p should be ideal. He had found a strong dependence of noise on collector voltage, and suspected that Mr. Stephenson's readings portrayed a function not of the encapsulation but of the method of measurement.

Transient Losses

Mr. E. H. Cooke-Yarborough commented on the suggestion by Light and Hooker that transient losses could be reduced by the insertion of a series diode with low hole-storage effect in the collector circuit. He did not think that this was possible, because the collector did not reverse at any time during the cycle and therefore the diode would not reverse either. Dealing with the drawing of circuits, he made a plea that positive should be put at the top to avoid confusion.

Mr. J. W. R. Griffiths said that his experiments on the variation of the noise factor with collector voltage showed that this did not vary very much with a low collector voltage, but at higher voltages it started to rise steeply.

Dr. G. R. B. Chaplin considered the operation by the transistor of a relay described by Hilbourne and Jones was a very useful application, because no voltage was needed to operate the transistor over that needed for the relay. He agreed with Mr. Cooke-Yarborough's comment on the suggestion by Light and Hooker. He himself had tried, mentally, to fit this diode which was supposed to reduce the hole storage, but could get no effect. He suggested symbols for junction and point-contact transistors which would distinguish between the n and p types.

Mr. M. Barry said that Hilbourne and Jones tended to regard as the optimum the common-collector arrangement, which, however, depended very much on the practical application. The common-collector type had an inherently lower distortion than the common-emitter type, but at the expense of lower power gain, which made a higher driving power necessary; the driver itself had to be a common-collector type of circuit. The consequence was that the driver was also a power amplifier and mismatching was likely not only in the output but also in the driver stage. This meant working inefficiently and a lower power gain by common-collector drivers than by common-emitter drivers. The authors' distortion figures for common-emitter arrangements were applicable to almost maximum power outputs, which in many cases would not be necessary, so that the current swing would not be so great and the distortion would be less. In receiving equipment, where gain might be of considerable importance, it might be far better to use the common-emitter arrangement for the output stage, as in most American receivers.

Transistors in Amplifiers

Mr. E. Wolfendall, dealing with the paper on power amplifiers, pointed out that transistors were made in which the current gain was maintained at a reasonably constant level up to high currents. In many cases where power transistors were used in amplifiers the battery drain was important, and the smaller the drain in the Class A transistor the better the life of the battery.

Mr. T. W. Sheppard said that no matter what the ambient temperature, the temperature rise above it before instability occurred would be about 11 deg C for germanium. The reverse voltage, however, would have to be reduced as the ambient temperature increased, because the leakage current also increased while the power dissipation for a given temperature rise remained the same. The losses which were not temperature-dependent caused a temperature rise equivalent in its effect to a rise in ambient temperature. The critical temperature rise before instability occurred would still be 11 deg C, but now referred to this effective ambient temperature, so that the temperature rise above the actual ambient temperature was increased; but the maximum permissible reverse voltage was still reduced below the value when no other losses were present; in the same way and for the same reason that it was reduced by an actual increase of ambient temperature.

High efficiencies were obtained with the Class B amplifier because when there was a good deal of current flowing there was little voltage across the transistor, and when there was a good deal of voltage across the transistor there was not much current; but if the base of the transistor was not driven sufficiently hard the power dissipation would increase. With a sinusoidal waveform the collector circuit losses could be increased by about 50 per cent if the peak collector current was reduced to 64 per cent of its possible maximum, but with square waves the dissipation in the transistor could increase five times if the peak current was reduced from 96 per cent of its theoretical maximum to 72 per cent.

Mr. F. F. Roberts said that in practice noise commonly did vary with collector voltage, and some noise dependence on voltage might be expected at the beginning of avalanche breakdown or with channel effect, which would be voltage-dependent and could be expected to have a random component and therefore to add to the noise.

Mr. F. Oakes and Dr. E. Billig made short contributions to the discussion, and the authors of all five papers made brief replies. Mr. D. D. Jones, on the question of symbols, emphasized the necessity of acting in agreement with the Americans. Mr. L. H. Light agreed that it had been an error to suggest that the series diode with low hole-storage effect in the collector circuit would effect a major improvement in transient losses.

Lecture at Royal Institution

ON 13th May Mr. R. W. Douglas, B.Sc., F.Inst.P., delivered a lecture at the Royal Institution on "The No-Man's Land Between Conductors and Insulators." The following is an abridgment of the lecture.

The crystal detector in the early wireless set consisted of a "cat's whisker" pressed on to a piece of one of the materials now known as semi-conductors. The peculiar properties of this class of materials are such that they cannot be considered either as metals or insulators, but as lying somewhere in the no-man's land between the two.

By studying gases, in which the individual atoms are still very far apart, a clear picture is obtained of the behaviour of each atom in isolation. If an electric current is passed through the gas a coloured glow appears, the colour of which is characteristic of each gas. The current has provided the outer electrons in the atoms with sufficient energy to jump into more energetic orbits. When they fall back again to their original orbits they give out a fixed quantity of energy which appears as visible radiation of a particular colour. This is the explanation of the characteristic colours of the argon, neon and helium discharges.

Radiation Absorption

In the same way, solid materials can be shown to absorb radiation. If a series of films of different semi-conductors is inserted between a source of radiation and the visible spectrum it emits, each film will cut off a different amount of the spectrum, beginning at the less energetic, i.e., the red end. Further, the semi-conductor, germanium, will cut off all visible light, but will transmit only infra-red radiation the presence of which can still be detected by using a thermopile.

For each material the different amount of light absorbed can be related to an electron jump, just as with mercury vapour. The difference between a solid and a gas, however, is that the solid absorbs all frequencies greater than a certain minimum, while the gas absorbs only the frequency corresponding to the energy required to excite an electron from one orbit to another. Instead of fixed orbits in the atomic model of the gas, which can be represented by thin lines, the model for the solid has broad bands of either permitted or forbidden energies which the electrons can or cannot inhabit. This change is due to the fact that, as the atoms are brought closer together to form the solid state, the isolated orbits begin to overlap and begin to form a series of bands.

In a metal one band which arises from occupied orbits overlaps with a band which is normally unoccupied. The electrons from the occupied band can then always move up into either energy level. When now an electric field is applied, the small additional amount of energy supplied can be absorbed by providing the electrons with more energy.

In semi-conductors and insulators, the bands do not overlap, i.e., a band occupied by electrons is separated from an unoccupied one by a region of energies which the electrons are not allowed to possess. If some radiation of sufficient energy falls on one of these materials it will be absorbed by an electron which can then jump from the full band into the empty or conduction band. If the radiation has insufficient energy for this it passes through without being absorbed. If the forbidden energy gap is not very wide enough energy for the jump may be provided in the form of heat, which explains why the germanium bar conducts electricity only when heated.

If a wire is connected to germanium containing arsenic impurity (n-type semi-conductor), with a galvanometer in the circuit, and the wire is heated, the galvanometer deflection is in the opposite direction from that obtained using germanium with indium impurity (p-type semi-conductor). In order to travel from the wire into the n-type material, electrons need to absorb energy in the form of heat, so that the junction will cool down. When the wire is heated, therefore, a current will tend to flow in such a direction as to cool the junction. At the junction of the wire in the p-type material, on the other hand, there is an evolution of heat as the electrons from the wire give off energy on entering the semi-conductor and a current in the opposite direction will be produced on heating the wire.

If now a junction is made between n- and p-type materials, electrons will tend to spill from the former to the latter. This produces a change in the potential of the p-type material until the number of electrons jumping one way across the junction exactly equals those travelling in the reverse direction. By connecting a battery across this junction device, different effects are obtained according to the direction in which current is made to flow. In one direction, the flow of electrons across the junction is reinforced, so that very large currents are obtained. In the other, the current will remain constant regardless of the applied voltage. This, of course, means that the device acts as a rectifier, behaving with a very high resistance in one direction and a very low resistance in the other.

Suppose now that a thin piece of p-type material is sandwiched between two pieces of n-type, and two batteries are connected so that one p-n junction has a high resistance and the other a low resistance. If the p-type semi-conductor is thin enough, current from the low resistance junction nearly all appears in the high resistance junction circuit. We can thus produce amplification, since a small change in current in the one part of the circuit can be produced by a small voltage. The same small change of current will appear in the high resistance circuit and produce a large change in voltage there.

Fire Protection of Office Buildings

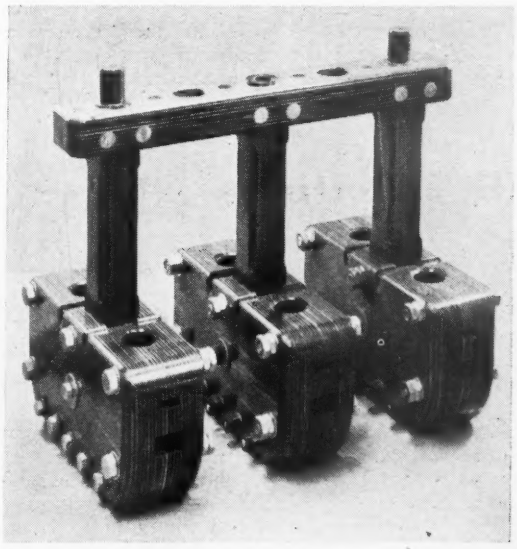
The Fire Protection Association, 15, Queen Street, London, E.C.4, has issued a booklet, "Fire Protection Notes for Office Buildings," in which elementary suggestions are made for the prevention of fire and suggested action to take when outbreaks occur. This includes hints for the maintenance in good order of electrical installations. Copies of the booklet can be obtained free from the Association.

Laminated Wood Insulation

The Gloucester Works of Permali, Ltd.

AMONG the smaller specialized units feeding the electrical industry of this country, the factories manufacturing insulating materials come high in the scale of importance. On their continued progress and constant research depends to a large extent the adoption of higher voltages for the national supply system; on their continued meticulous attention to quality at every stage of production depends much of the reputation of manufacturers whose finished products often rely on theirs.

One firm of this nature with a record of steady development and expansion is Permali, Ltd., of Gloucester, whose products play a vital part in the construction of many circuit-breakers, and other plant, up to the highest voltage, now made in this country. Permali, whose works at Gloucester and Cheltenham we were shown recently, manufacture principally a resin impregnated and densified laminated wood, the main characteristics of which are a very high mechanical strength, good electrical characteristics and low moisture absorption, together with dimensional stability. Manufacture at Gloucester is for the most part based on a customer's individual order, following on which a selection of dried veneers, suitably sized for the job, and in thicknesses of 1 or 2 mm, is packed in baskets layered by wire grills and immersed in an impregnating vat, under vacuum. After this the baskets are transferred to chambers where hot air blown over them evaporates the solvent base of the impregnating material and any free moisture still present.

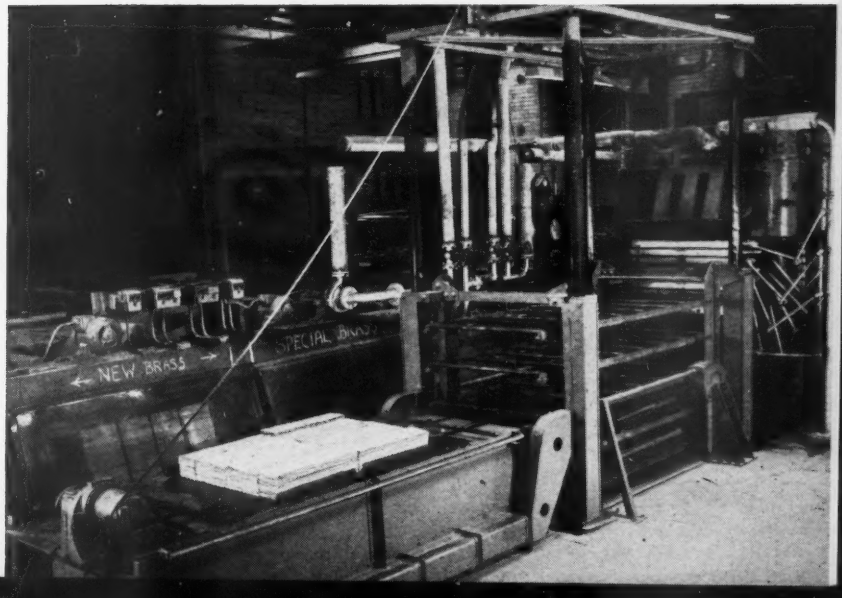


An 11 kV moving bridge assembly in Permali

The moisture absorption of the ordinary grade of Permali is only about 1 per cent by weight in 24 hours' immersion, and a tropical grade recently introduced absorbs less than 0·3 per cent in the same period. A third grade has been developed highly resistant to chemical attack, for use in the chemical industry. Of note is the introduction of a dye into the tropical and chemical grades, producing a black and green colour in the finished product and obviating any possible confusion. After a period in the evaporating chambers the veneers are stacked in the lay required for the particular job. The makers claim as one of the advantages of their product that the mechanical properties can be varied at this stage to suit the requirements of the finished article. If all the veneers are laid together with the fibres lengthwise, the finished piece has high tensile strength in this direction; if they are laid with the fibres of each successive layer at right angles, rigidity and resistance to compression, as well as a tensile strength equal in both directions is obtained. Alternatively for applications such as gears, the laminations may be arranged with each successive layer having its fibres at a slight angle to those of the next, so that the strength is equal in all radial directions.

Once laid up the assembly of veneers is placed in a hydraulic press where, in contact with platens heated by hot water to about 160 deg C it is subject to about 1 ton/sq in pressure. After the requisite period the sheet is allowed to cool under pressure to relieve internal stresses which may be present. Stainless steel sheets can be used in contact with the veneer to produce a very high gloss finish.

Before being assembled for pressing the individual pieces of impregnated veneer are trimmed to exact size. The trimmings are ground into even particles and used for a moulding powder—a good example of apparent waste being turned to a good use. Boards made of this powder

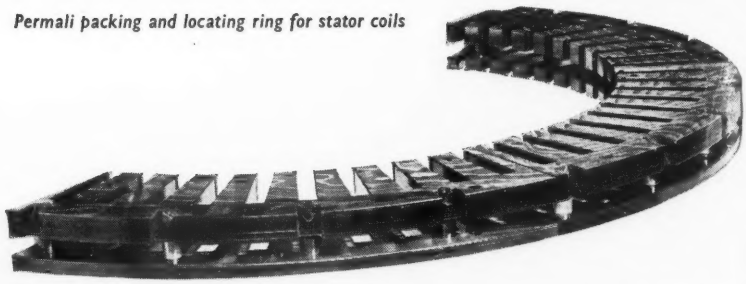


An insulation press, showing a veneer making-up table in the foreground

can be used for l.v. insulation work.

Sample pieces from each production are given routine tests for specific gravity, which is very closely controlled, water absorption over 24 hours, dimensional increase after water immersion, bending strength, impact strength, volatile content, and electrical breakdown tests normal to and along the laminations. Machining is carried out at another of the company's factories at Cheltenham. Here a combination of woodworking and metalworking machines are adapted for working Permali, in a spacious modern machine shop. Provided special tools are used and high working speeds, the material can be machined to an accuracy approaching that achieved in metalworking practice.

Permali packing and locating ring for stator coils



Emphasis is placed throughout manufacture on quality control and this is completely in the hands of the research laboratory staff, recording and indicating machinery being installed at all production processes to enable an accurate watch to be kept. From start to finish the production of an order is an individual process. It is not a rapid process and it is not cheap but a growing demand by electrical manufacturers indicates that the material has a definite role to fill at a time when insulation technique is becoming rapidly more and more important. The growing size of power transformers and turbo-generators involves the insulating materials used in disproportionate mechanical stresses under short circuit conditions; and to meet these conditions Permali is being used for transformer end rings and generator conductor supports.

Switchgear lifting rods and guides, cross jet switch pots, operating links and rods are extensively made with it, as well as such items as stay-wire insulators, gears and general insulation applications. One extensive use is for fishplates where track-circuit insulation is required. Two laminated and shaped plates are used and perform the normal duty of a steel fishplate as well as serving as insulation.

The company supplies Permali in sheet, block or rod form if required but having a well developed technique and machine shop for working the material, it prefers to supply a finished article ready for use by the electrical industry. This has the added advantage that by putting a job through all stages of production with the ultimate article clearly in mind, waste of all kinds is minimized.

Permali also manufacture indoor and outdoor bushings for use at voltages up to 69 kV and the processes seem characterized by the same individual attention as is the case with the laminated wood insulation.

Wiring of Small Dwellings

IT is too often the case that specifications for the electrical wiring of small dwellings are drawn up by people with small knowledge of the requirements in a modern home—either of the extent or nature of the installation needed. In an endeavour to improve matters in this respect the Electrical Contractors' Association (14, Bedford Row, London, W.C.1) has prepared a set of three specifications for the use of its members, together with introductory notes setting out the requirements in general terms. It is the intention that these shall be brought to the notice of architects, surveyors and others concerned in the design and construction of small houses.

The introductory notes begin with the consumer's service unit which, it is recommended, should be put in an accessible position and as near the kitchen as possible—to reduce the length of wiring needed. Adequate fuse-ways for socket-outlets are called for and the use of a separate fuse for the lighting on each floor is recommended. The correct sizes of cables for cookers are given as 7/·036 for up to 6 kW and 7/0·44 for over 6 kW and up to 8 kW total loading.

Switch covers secured by two screws are preferred to screwed caps and the provision of a sufficient number of socket-outlets is advocated. Attention is called to the need for using the appropriate size of fuses in plugs.

There follow some notes on the installation of immersion heaters, stress being laid on lagging and thermostatic control; the use of a pilot light to show when a heater is on is recommended.

Concealed wiring should be in horizontal and vertical runs; a diagonal run entails greater danger of penetration by nails driven into the wall. Proper care in the installation of conduits and cables in roof spaces where there are water tanks is counselled.

As regards earthing, it is suggested that as it is not always possible to ascertain characteristics before tendering it is advisable to quote two prices to cover normal and abnormal conditions.

The three specifications are as follows. They apply to houses with a floor area not exceeding 1,500 sq ft:—Installation in heavy gauge screwed conduit and screwed fittings with v.i.r. cables; installation in light gauge welded conduit and lug grip fittings with v.i.r. cables; and installation in tough rubber sheathed cables.

The specifications are printed with a wide margin on the left-hand side to enable them to be bound with other tender documents and they bear no indication that they emanate from the Association. Copies of the specifications cost 6d each; the cost of the set of three is 9d, including postage.

Sets of the documents have been sent to local authorities throughout the country.

E.A.W. BRANCHES

The inaugural meeting of the Lowestoft and District E.A.W. Branch was held on 10th May, when the Mayor, Ald. J. M. Lang, J.P., gave a civic welcome. The new branch officers are:—Vice-chairman, Mrs. Carr; hon. secretary, Miss Peck; and hon. treasurer, Mrs. Wood.

The Farnworth and District E.A.W. Branch celebrated its 21st birthday at a dinner, when the chief speaker was Sir Joseph Hallsworth, chairman, North Western Electricity Board.

Watford and Aylesbury Branches recently celebrated their 21st birthdays.

Electro-deposition of Metals

Institute of Metal Finishing Conference

THE annual conference of the Institute of Metal Finishing has been held in Torquay during this week. Among the earlier papers presented was one by Messrs. C. Williams (Armament Research Establishment) and R. A. F. Hammond on the effect of chromium plating on the fatigue strength of En (Ni - Cr - Mo) steel of 65 and 80 tons/sq in ultimate tensile strength in two conditions of heat treatment, i.e., "as plated" and after determination of post-plating heat treatment up to 620 deg C. The authors confirmed previous reports of reduction in fatigue strength by plating, of further marked reduction below 300 deg C and of the benefit of heat treatment at 440 deg C. They showed the relationship between internal stress in the deposit and fatigue limit of the base metal and also the effects of post-plating heat treatment under similar conditions. Changes in the fatigue limit appeared to be governed jointly by the nature and amount of internal stress and by the inherent fatigue strength of the chromium deposit.

Methods of depositing iron-zinc alloys of 3 to 90 per cent zinc content from sulphate baths were discussed by Miss S. Jepson, Mr. S. Meecham and Dr. F. W. Salt (British Iron & Steel Research Association Coatings Laboratory). It was stated that alloys with zinc contents greater than 15 per cent did not corrode in normal indoor atmospheres and had been used as linings of steel vessels (protecting the steel from decarbonization and from sulphur compounds) in which crude oil was treated with hydrogen at 200 atm and 450 deg C. Those in the 15 to 30 per cent range, in view of their hardness, might replace nickel in electrotypes. Thin deposits of up to 30 per cent might provide a base for painted coatings on steel, giving sacrificial protection at pores in the paint film; with 60 per cent zinc no additional protection was needed for decorative purposes within doors. Corrosion tests were now in hand to ascertain the suitability of 30 to 70 per cent alloys as an alternative to nickel as a base for chromium plating.

Resistance to Corrosion

Corrosion tests of tin-cadmium coatings on steel were described by Messrs. S. C. Britton and R. W. de Vere Stackpoole. Compared with cadmium coatings the performance of an alloy of up to at least 50 per cent tin when applied to steel was equal to that of cadmium in preventing rusting at pores when freshly exposed to corrosion. In laboratory tests with 3·5 per cent sodium-chloride solutions, the alloy protected steel for much longer. On panels exposed to marine environments the results were similar, but inland the alloy protection was for a shorter period. Alloy coatings were more resistant to corrosion by organic vapours such as were given off by some insulating materials, the improvement tending to increase with the proportion of tin. Pre-coating with tin to obtain more uniform coatings of zinc or cadmium on complex shapes did not depreciate the protection value.

An experimental study of chemical polishing of mild steel by hydrogen-peroxide-oxalic acid mixtures formed the subject of another paper by Dr. A. Hickling and Mr. A. J. Rostron (Liverpool University). Polishing occurred, they said, when the metal was alternating between the active and passive states and was accompanied by a periodic variation in the rate of dissolution and the potential of the specimen.

Under these conditions the metal was partly covered by oxide, voltaic couples being set up in which current flowed from oxide-covered hollows to base metal peaks on the surfaces. Another paper from the Armament Research Establishment dealt with the electrolytic oxidation of copper and copper alloys in hot 15 per cent caustic soda solution with a small addition of molybdic oxide. The coating formation appeared to take place through initial and continual production of cuprous oxide, part of which was further oxidized to cupric oxide. A coating of 0·0001in was obtained at 15 A/sq ft at 85 deg C.

Electrodeposits of Silver

A detailed study of the structure and growth of electrodeposits of silver from a cyanide bath and the modifications caused by brightening agents was presented by Dr. H. Wilman (Imperial College, London). The author concluded that the temperature at the immediate surface of growing deposits reached 600 deg C or more, the crystals growing under conditions usual in condensation from the vapour. Brightening resulted when crystals formed surfaces which were large and smooth relative to the light wavelength.

An account of experimental exploration of cracking in chromium deposits applied from conventional solutions at various temperatures and current densities was given by Mr. H. Fry (British Non-Ferrous Metals Association). He had found that striations parallel to the basis metal were associated with cracking. Striations became wider and cracks increased in depth but decreased in number with rising deposition temperature, disappearing at 75 deg C. It was tentatively suggested that cracking might be due to a reduction in tensile strength associated with structural abnormalities in the region of the striations.

In submitting a new method of analysing stresses and strains in deposited coatings, Mr. H. J. Pick suggested that processes leading to stress formation should, for research purposes at least, be discussed in terms of the accompanying linear free strain (rather than of secondary effect of stress), i.e., the strain which a coating would undergo in a direction parallel to the base if deposited on an infinitely thin base of no mechanical strength. Formulæ were evolved which were applied to the electrodeposition of copper.

The electrodeposition of tungsten-cobalt alloys from aqueous solutions was discussed by Dr. T. P. Hoar (Cambridge University) and Mr. I. A. Bucklow (Imperial Chemical Industries). The authors set out the conditions for producing sound coherent deposits when operated at 50 to 70 deg C with interrupted d.c. pulses of 0·05 to 2 sec, the cathode current density being 5 to 20 A/dm^2. The electronic structure of the alloy cathodes was shown to be much more favourable than that of tungsten for hydrogen deposition and probably for tungsten deposition also.

London's Electricity Supply

History Surveyed at I.E.E. Meeting

IN a paper presented before the Institution of Electrical Engineers' Supply Section, Mr. D. B. Irving (London Electricity Board) surveyed briefly the history of the supply of electricity in London as a basis for assessing savings in capital and operating costs and improvements in electrical efficiency as a result of centralization under the Electricity Act of 1947. The Area dealt with covers 257 square miles, which is less than one-tenth of the size of the next smallest Board Area; it has nevertheless a population of 5 million, the density being more than twenty times that of any other Area.

Before vesting day, 1st April, 1948, electricity was distributed by 30 municipal and 10 company undertakings, which supplied consumers on single-, two- and three-phase and d.c. systems at 20 voltages from 100 to 500 and published 270 different tariffs. There were 18 high voltage systems at from 1 kV to 11 kV. In addition the London Generating Division now operates the 132 kV overhead and underground interconnections and the London Board the underground networks at 66, 33 and 22 kV. Many cables have been regraded, e.g. from 6·6 to 11 kV, without trouble.

Substantial savings have been made by minimizing distances for transmission of bulk supplies. An instance was given in the *Electrical Review*, 26th February, 1954, of one item by which there was a capital saving of £750,000 and a resurrent annual saving of £35,000 from reduced losses. Such savings will tend to increase, aided by an extended use of high voltage transformer-feeder circuits, which will economize in switchgear.

Voltage is reduced from 66 kV in seven main substations containing 500 MVA of transformers. In 72 main 33 kV and 22 kV substations are installed 2,264 MVA of transformers and in 7,128 local substations 3,536 MVA for transformation to medium voltage and under. Prospective short-circuit duties are limited as far as possible to the following values: at 66 kV, 1,500 MVA; 33 kV, 750 MVA; 22 kV, 500 MVA; 11 kV, 150 MVA. Transformer ratings in the 66 kV substations range from 15 to 50 MVA and in the 33 and 22 kV substations from 3 to 20 MVA. Up to 15 MVA they are generally oil-immersed with natural air cooling; above 15 MVA forced oil circulation and air blowing are employed at over half load. Most bulk-supply transformers now being installed are fitted with a 20 per cent range of tap-changing. Distribution transformers have been standardized at 500 kVA.

Total cost of standardizing medium voltage systems is estimated at £50 million. The Board has 170,000 d.c. consumers and 627,000 non-standard a.c. consumers. Last year 37,000 were changed over, but at that rate of progress (dictated by restrictions on capital expenditure) complete standardization will take many years.

Four standards for cables have been established, viz.: small isolated loads, telephone kiosks and public lighting, v.r.i. or p.i.l.c. 0·007 sq in; normal domestic premises and shops, twin or four-core p.i.l.c. 0·0225 and 0·06 sq in; larger services, four-core p.i.l.c. cable 0·10 sq in.

About 24 per cent of faults since vesting day have been due to causes out of the Board's control. Faults at 66 kV have averaged one per annum per 100 circuit miles and those at 33 kV and 22 kV of 1·6 per annum per 100 circuit miles. The 11 kV and 6·6 kV cable systems have suffered 0·5 fault per 100 circuit miles per annum from mechanical damage and a similar number from failures in joints and terminations. Electrical efficiency has improved in the past six years from 86·55 to 88·49 per cent; each one per cent represents an annual saving of nearly £150,000.

The average annual rate of growth of maximum demand is about 100 MW. No demand saturation is in sight and the total is expected to reach 3,250 MW around 1970. Apart from replacement of non-standard equipment, the rate of reinforcement is expected to be equivalent to two or three main points of supply each year, half the rate of the past five years. Increasing difficulty in obtaining sites near the load demand may necessitate resorting to compulsory powers more often than in the past.

Radio Research

THE report of the Radio Research Board for 1954 (H.M. Stationery Office, price 2s 6d) shows that the main emphasis of the research programme for the year was on the problems of wave propagation, a proper understanding of which is essential if the best possible use is to be made of the already crowded radio frequency spectrum.

The Board points out that, although it is not easy to assess the economic value of the research work on propagation, the radio industry, particularly the operating side, continues to benefit from the knowledge that has accumulated over many years. The forecasts of ionospheric conditions, for instance, are used by all British authorities concerned with long-distance broadcasting and point to point communications. The work on very low frequency propagation is particularly applicable to radio navigational aids while that at very high frequencies and ultra high frequencies is valuable because of developments in British sound and television broadcast services. The importance of rapid world-wide communication to commerce, the part played by radio navigation and communications in air and sea travel, and the present expansion of sound and television broadcasting all demand that research resources on propagation should be sufficient to meet present requirements and anticipate those likely to be required in the future.

Another important field for fundamental research is that provided by the range of new materials which is being used in radio components and equipment. The element germanium is receiving particular attention because of its increasing use in transistors.

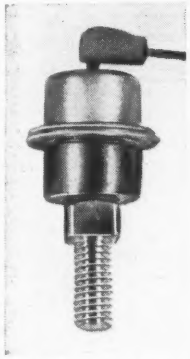
The crystallographic, electrical and magnetic properties of ferrites are being studied on behalf of the department, at Imperial College, London. The design of assemblies of conducting elements for dispersive dielectrics at centimetre wavelengths are also being studied. It may be possible in this connection to develop materials of which the refractive index varies rapidly with wavelength and so devise radar scanning aerials in which a small change in the wavelength of the signal transmitted would vary the direction in which the beam is projected.

Up to the present time temporary buildings in the grounds of the Admiralty Compass Observatory, Ditton Park, have been used. Work commenced during the year on a new permanent building to accommodate administrative offices, laboratories and workshops and it is expected that this will be ready for occupation by the end of 1955.

NEW ELECTRICAL EQUIPMENT

Medium Power Germanium Junction Rectifier

The GENERAL ELECTRIC CO., LTD., Magnet House, Kingsway, W.C.2, has recently introduced the first germanium p-n junction rectifier for use in medium voltage and current circuits to become commercially available in this country. A 50 c/s full wave bridge, using four of the new type EW54 rectifiers, will provide a maximum output power of 1 kW with an input voltage of 50 V r.m.s.



Full size view of type EW54 rectifier

The EW54 rectifier, which is shown full size in the illustration, is only 1½in long and has a maximum diameter of ⅝in. Careful attention has been given to the hermetic sealing of the unit so that the sensitive p-n junction is completely shielded from the deleterious effects of moisture. The higher power ratings, such as that mentioned above, are obtained when the EW54 is mounted in small cooling fins.

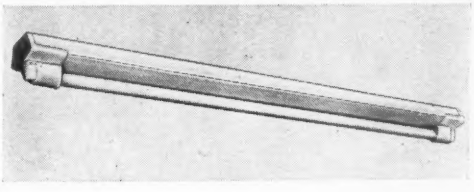
The device has a high rectification efficiency, arising from its low forward resistance, and this, combined with its small size, makes it especially suitable for vehicle and aircraft applications.

"Ceiline" Lighting Fitting

The "Ceiline" industrial fluorescent lighting fitting introduced by CROMPTON PARKINSON, LTD., Aldwych, London, W.C.2, is specially designed for close-to-ceiling mounting. Easy installation and servicing features incorporated in the design include simple fixing arrangements suitable for all forms of sunken or surface wiring, positive earthing and earth continuity facilities, die-cast end plates with knock-outs for surface conduit, and a readily accessible patent visible action starter switch.

Provision is made for the unit to be temporarily suspended from the two ceiling catches at an angle that permits ready accessibility to the tapped high-power-factor control gear for connection purposes. When the wiring has been completed, the fitting is slung into its correct position and then drawn up close to the ceiling by the simple adjustment of two knurled nuts.

Insertion or withdrawal of the tubes is facilitated by the incorporation of spring-loaded lampholders at both ends of the unit and by the sliding, self-retaining plastic lamp end-shields. Any 5ft 80 W lamp can be used. The fitting has the Crompton special "Permawhite" enamel finish, all the steelwork being "Bonderized" during the finishing processs. The total weight is 17 lb and either 200/250 V switch start gear or 220/250 V snap start gear can be supplied.



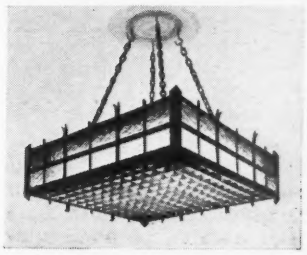
Crompton "Ceiline" fitting

Overfloor Ducting System

A ducting system intended for use in buildings where a floor duct system is required and where existing floors cannot be interfered with is announced by CHANNEL CONDUITS, LTD., 11, Victoria Street, London, S.W.1. The system consists of rectangular zinc coated steel ducts 1in wide and ½in deep in which the wiring is laid. The ducting is enclosed and protected throughout by shaped capping of tough hardened rubber. An adhesive compound supplied fixes the underside of the capping to the floor and partitioning inside the ducting by means of steel fillet insertions enables low voltage services to be placed in the same duct.

Fluorescent Fitting

An artistic fluorescent lighting fitting designed for hotel lounges and large restaurants is now available from SCEMCO, LTD., 6, Soho Street, London, W.1. It houses four 2ft 40 W lamps and the control gear, and measures approximately 2ft 6in square with an overall depth of 8in. Each side of the "Tudor" fitting consists of twelve amber "Old English" glass pieces. The louvred, panelled base has a 1½in square mesh designed to give an even, diffused light.



Scemco "Tudor" fluorescent fitting

The fitting, which has a chain suspension, retails at £26 5s complete with gear but excluding lamps, plus purchase tax in the United Kingdom.

Lighting Fittings for Modular Co-ordination

A new series of recessed lighting fittings made to dimensions acceptable to the building industry has been introduced by the BRITISH THOMSON-HOUSTON CO., LTD., Crown House, Aldwych, London, W.C.2, the aim being to eliminate the past policy of cutting to waste where a building component, such as a ceiling panel, meets another, such as a lighting fitting. The conception has gained popularity under the title "modular co-ordination."

These Mazda "Module" fittings are made in 2ft by 2ft, 2ft by 4ft and 2ft by 6ft sizes and are completely interchangeable with standard 2ft by 2ft or 2ft by 1ft ceiling panels, of which a wide selection of proprietary brands are used. They may be installed in a standard suspended ceiling in any desired arrangement and they may be rearranged at any time to suit new requirements without structural alterations.

The fittings may be mounted adjacent to each other without overlap because they are suspended independently of the false ceiling and completely integrated with the ceiling panels. They consist of a box constructed of sheet steel with a flange that sets into the ceiling and are available for housing two or four fluorescent lamps with control gear, or tungsten filament lamps. A wide variety of diffusing panels may be used to obtain different lighting effects, including opal "Perspex" biscuits, diffusing glass and metal or plastic louvres.

It is believed that this is the first time that standard fittings with these characteristics have been available in this country or indeed anywhere in the world.

2ft "Module" panel for recessing into a false ceiling

Domestic Electrical Equipment

Coffee Percolators

APART from its utility value, the electric coffee percolator is also an attractive addition to the equipment of the modern home. Both automatic and non-automatic types are available, the former being fitted with an additional element which keeps the coffee hot after percolation has been completed. Should the percolator be allowed to boil dry, or be inadvertently switched on when empty, a safety cut-out incorporated in most models prevents damage.

The average capacity of percolators is between 1½ and 2 pints, sufficient for from six to eight cups of coffee. The majority of models are finished in chromium and are provided with heat-resisting moulded handles, although some manufacturers favour a porcelain material. With this type, the makers claim, the ceramic pot helps to retain the full coffee flavour. Matching coffee sets can also be obtained.

Loading of the 1½ pint size is in the region of 500 W, all models being suitable for the normal 200/250 V supply. Being classed as an item of cooking equipment the electric coffee percolator is not subject to purchase tax, and considering its advantages, the average price, £5 10s 0d, is not excessive.

Manufacturer	Name or Model	Type	Capacity	Element Loading	Body	Handle	Special Features	Price
BEST PRODUCTS, LTD., Felix Works, Felixstowe, Suffolk.	"Best" No. 2	Automatic	2½ pt	500 W	Chromium plate on copper	Black Bakelite	Automatic safety cut-out. Indicator lights. Pre-set percolation	£5 17 6
	"Best" No. 3	Non-Automatic	2½ pt	500 W	Chromium plate on copper	Black Bakelite	—	£3 17 6
BULPITT & SONS, LTD., St. George's Works, Icknield Street, Birmingham, 18.	"Mayfair" 480 S	Non-Automatic	1¾ pt	400 W	Chromium plate on copper	Heat resisting moulded plastic	Automatic safety cut-out. Manual reset	£5 5 0
	"Dorchester" 450 S	Non-Automatic	2 pt	400 W	Polished aluminium	Heat resisting moulded plastic	Automatic safety cut-out. Manual reset	£3 12 6
"CONA" COFFEE MACHINE CO., Felden Works, Railway Place, Wimbledon, S.W.19.	"De-Luxe" Table Model	I, II, IIA and III	½ to 2 pt	350 W	Chromium plated zinc stand. Glass bowls	Wooden	Accessories include funnels and drainer	£4 2 6 to £5 5 0
	"Rex"	Enclosed element	1½ pt	350 W	Cast aluminium stand. Glass bowls	Incorporated in body	On-off switch. Obtainable in range of enamelled colours	£7 17 6
	"F.B.103"	Single	3 pt	500 W	Chromium plated steel hot-plate. Glass bowls	Moulded	Simmerstat control. Complete with accessories	£15 15 0
A. D. DAVIDSON ELECTRIC CO., 62-66, Granville Street, Birmingham, 1.	"Davey" C.601	Urn	1½ pt	400 W	Chromium plate on copper	Bakelite	Fitted with tap	£4 14 6
	"Davey" C.603	Urn	2½ pt	500 W	Chromium plate on copper	Bakelite	Fitted with tap	£5 15 6
	"Davey" C.606	Urn	4½ pt	950 W	Chromium plate on copper	Bakelite	Fitted with tap	£8 7 6
	"Davey" C.618	Jug	1½ pt	400 W	Chromium plate on copper	Bakelite	—	£5 2 11
ELGA PRODUCTS, LTD., Railway Place, Wimbledon, S.W.19.	"Autoperc" A.35	Automatic	1½ pt	500 W	Staffordshire pottery	As body	Matching coffee service available £3 3 0 extra	£5 10 0
	"Autoperc" A.30	Automatic	1½ pt	500 W	Chromium plate on copper	Moulded plastic	Automatic action	£6 10 0

Elga "Autoperc" coffee maker

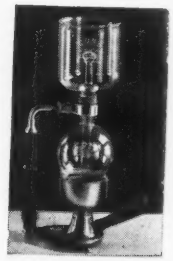
Bulpitt "Mayfair"

Bulpitt "Dorchester"

"Davey" C.601 urn type percolator

Best Products "No. 2" percolator

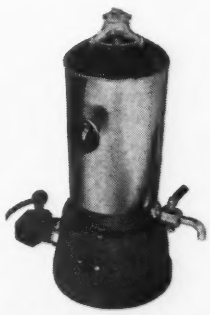
Cona "De-Luxe" table model



Manufacturer	Name or Model	Type	Capacity	Element Loading	Body	Handle	Special Features	Price
F. & F. ELECTRICAL FITTINGS CO., LTD., 33, Alfred Place, London, W.C.1.	"De-Luxe"	—	2 pt	750 W	Chromium plated and aluminium	Two knobs	Fitted with tap	£4 15 0 (chromium) £3 15 0 (aluminium)
FALK, STADELMANN & CO., LTD., 91, Farringdon Road, London, E.C.1.	"U.95628"	Automatic	1½ pt	560 W	Chromium plate on copper	Heat proof plastic	Coffee kept hot automatically	£6 10 0
	"U.95648"	Automatic	1½ pt	560 W	China	China (incorporated in body)	Coffee kept hot automatically	£5 10 0
GENERAL ELECTRIC CO., LTD., Magnet House, Kingsway, London, W.C.2.	"D.5372"	Non-Automatic	1½ pt	400 W	Chromium plate on copper	Black Bakelite	Automatic re-set safety device	£6 5 0
HOTPOINT ELECTRIC APPLIANCE CO., LTD., Fletton, Peterborough.	"614 PI"	Non-Automatic	8 cups	400 W	Chromium plate on copper	Black moulded plastic	Safety protection device	£5 10 0
LINCASS ELECTRIC, LTD., Guildford Street, Chertsey, Surrey.	"651"	Non-Automatic	1½ pt	500 W	Chromium plate on copper	Bakelite	Earthed connector	£3 18 0
	"654"	Non-Automatic	1½ pt	500 W	Chromium plate on copper	Bakelite	Switched connector	£4 0 0
PREMIER ELECTRIC HEATERS, LTD., Keeley Street, Birmingham, 9.	"652"	Non-Automatic	8 cups	400 W	Chromium plate on copper	Bakelite	Safety protection device. Glass top	£5 10 0
RUSSELL HOBBS, LTD., 1, Bensham Lane, West Croydon, Surrey.	"C.P.1"	Automatic	1 to 2 pt	600 W	Primrose, dove grey and green ceramic	Ceramic	Safety cut-out	£3 17 6 (a.c.) £4 4 0 (a.c./d.c.)
S.L.R. ELECTRIC, LTD., Welbeck Road, South Harrow, Middlesex.	"C.B.6"	Glass vacuum	1½ pt	500 W	Heat resisting glass	Black Bakelite	Triple filter cloth	£2 12 6 to £3 0 0
	"C.B.12"	Glass vacuum	2½ pt	660 W	Heat resisting glass	Black Bakelite	Triple filter cloth	£3 5 0 to £3 12 6
F. J. TOMLINSON, LTD., Hall Carr Mill, Rawtenstall, Rossendale, Lancs.	"Handy"	Non-Automatic	2 pt	450 W	Chromium plate on copper	Wooden	Removable siphon interior. Glass top	£4 4 0

Lincass "651"

Falk Stadelmann U.95628



F. & F. Electrical Fittings "De-Luxe"

Premier "652"

G.E.C. "D.5372" percolator

Hotpoint "614PI" percolator

Russell Hobbs automatic coffee pot

S.L.R. "CB6" coffee brewer

GENERATION AND DEVELOPMENT

Output in April

Electricity generated in April showed an increase of 8·3 per cent. In the first four months of the year 29,184 million kWh was generated, as compared with 26,016 for the corresponding period of 1954, an increase of 12·2 per cent. At the end of April the installed capacity in stations of the Central Electricity Authority, the North of Scotland Hydro-Electric Board and the South of Scotland Electricity Board was 20,836 MW. This represents an addition of 17 MW during the month.

Manx Arbitrator's Award

In consequence of the Isle of Man Electricity Board's decision to end its arrangement for the purchase of electricity from the Douglas Corporation the Corporation claimed compensation. It contended that too short a notice was given by the Board in consequence of which the Corporation had proceeded with a 5,000 kW extension of its Pulrose power station. The sum claimed was £149,000 but an arbitrator (Mr. R. W. Gregory, M.I.E.E.) appointed by the Governor of the Isle of Man has decided that £63,000 should be paid and the costs of his inquiry equally shared by the two parties.

Large Supply Reinforcement

The South of Scotland Electricity Board has approved the second stage of a scheme for the reinforcement of supply in Largs, and the changeover of the network from 3·3 kV to 11 kV operation, at an estimated cost of £12,998. Three existing substations will be replaced by a new 500 kVA substation to be built at Lade Street, and the substation at Barrfields Pavilion will be re-sited and re-equipped.

Sowerby Bridge Substation

One of the first tasks of the Yorkshire Electricity Board after vesting date was to survey the need for system extensions to deal with immediate and future load growth. Such a survey carried out in the Calder Valley region indicated that the existing surplus capacity of the primary system would be inadequate to meet the forecasted load growth during the next ten years. To deal with this position, a major scheme of primary system reinforcement was prepared. A site was acquired at Sowerby Bridge for the main substation and work which was started there two years ago has now been completed. A recorded load in this region of 25,000 kW in 1949 has now grown to 40,000 kW. The substation provides a new point of bulk supply from the 132 kV transmission system of the Central Electricity Authority, Yorkshire Division. The supplies are stepped down at this substation from 132 kV to 33 kV by means of transformers for feeding outgoing overhead lines in a westerly direction to Todmorden and in an easterly direction to Salterhebble. The supplies are also stepped down at the substation from 33 kV to 11 kV for feeding cables which radiate into the local network to provide general system reinforcement locally. At Todmorden and Salterhebble, the existing 33 kV primary substations are being reconstructed and equipped with larger transformers for stepping down the supplies from 33 kV to 11 kV to provide general system reinforcements in the respective areas of supply.

The opening ceremony was performed by Councillor E. Lumb, J.P., chairman of the Sowerby Urban District Council, in the presence of the chairman, deputy chairman and part-time members of the Board, the Mayors of Halifax and Todmorden, and the chairman of the Urban District Councils of Hebden Royd, Ripponden and Hepton.

Mr. D. Bellamy (chairman, Y.E.B.) addressing the gathering at the opening of Sowerby Bridge substation. Behind him is Councillor E. Lumb, J.P., who performed the opening ceremony

Kilmarnock Reinforcement

The South of Scotland Electricity Board has approved a scheme for the reinforcement of the supply to Kilmarnock. A new 33/11 kV substation will be erected at Langlands Street and two 33 kV cables, approximately 1½ miles in length, will be laid between Langlands Street and the Kilmarnock switchhouse at Greenholm Street. The estimated cost of the work is £101,700.

Stanmore Line Resignalling

New signalling equipment on the four-mile section of the Bakerloo Line between Wembley Park and Stanmore will permit trains to run on a 2 min headway in future, instead of a 3½ min headway as hitherto. The work has taken fifteen months to complete; during this time 58 new signals and some 70 miles of cable runs have been installed. This is the second stage in the scheme for improving the Bakerloo Line service; last September it was provided with separate tracks from those of the Metropolitan Line at Wembley Park.

Site for Ulster Station

The Mayor of Londonderry (Senator S. S. Dowds, J.P.) and technical advisers from the local electricity undertaking last week met representatives of the Northern Ireland Joint Electricity Board for informal talks on the erection of a new power station. When he seconded the address in reply to the Queen's Speech in the Ulster Senate recently, Senator Dowds referred to the Government's decision to erect a large generating station on a site outside Belfast and to the Londonderry Corporation's plan for a new station, and suggested that the Minister of Commerce should consult the

ELECTRICITY GENERATED AND PLANT INSTALLED*

	Fuel consumed Thousand tons			kWh generated Millions			kWh sent out Millions	Installed capacity (m.c.r.) MW
	Coal	Coke and Breeze	Oil	Steam	Water power	Total†		
British Electricity Authority ...	2,901	96	16·5	5,577	7	5,591	5,243	18,985
N. of Scotland H.E.B.	26	1	1·1	38	71	114	112	629
S. of Scotland E.B.	196	8	0·1	382	15	397	375	1,222
Total for April, 1955	3,123	105	17·7	5,997	93	6,102	5,730	20,836
Corres. total for April, 1954 ...	2,960	99	8·1	5,520	103	5,634	5,294	19,208
Inc. or dec. per cent	+5·5	+6·1	+118·5	+8·6	−9·7	+8·3	+8·2	+8·5
Total to date (4 months) 1955 ...	15,284	452	92·1	28,595	527	29,184	27,482	—
Total for corres. 4 months 1954...	13,916	419	56·0	25,438	525	26,016	24,497	—
Inc. or dec. per cent	+9·8	+7·9	+64·5	+12·4	+0·4	+12·2	+12·2	—

* Comprising all generating stations controlled by the Central Electricity Authority, the North of Scotland Hydro-Electric Board and the South of Scotland Electricity Board.

† The total figure includes generation by other methods amounting to 12 million kWh in April, 1955.

Corporation with a view to co-ordinating the two proposals.

According to the city electrical engineer (Mr. S. J. Spence), if a new station were to be erected it would be a major undertaking capable of supplying most of the North-West. There would be no question of building a new station to cater for the city and district only. Among sites being considered for the station is one at Lisahally on the River Foyle. The Minister of Commerce (Lord Glentoran) announced in March last that a firm of London consultants had begun investigations into the various technical aspects of the power station programme for the Province.

Transfer of N.S.W. Undertaking

The Sydney County Council will take over the Sutherland Shire Council electricity undertaking on 1st July. The general manager of the Sydney County Council, Mr. C. E. Ranger, reported this to a Council meeting on 21st April, following negotiations over the past twelve months on a proposal by the Shire Council that the County Council should take over the system. The Sutherland undertaking is one of fifteen local undertakings in the County of Cumberland which distribute electricity independently of the County Council. Local councils operating other undertakings have strongly opposed moves to transfer their undertakings to the County Council's control.

Hospital Installations

Electrical rewiring schemes involving expenditure of more than £320,000 are planned by Sheffield Regional Hospital Board under the Ministry of Health's hospital building programme. They include work costing £90,000 for Nottingham General Hospital, £52,000 for The Towers Hospital and £51,000 for the Fir Vale Infirmary. Other hospitals concerned are the Loughborough General, The Saxondale, Sheffield City General and Nether Edge.

Included in the Hospital Board's plans is a general allocation of £30,000 for electrical safety in operating theatres. In a report the Board say considerable defects were brought to light by the electrical safety engineers of the Ministry of Health. The report adds: "Many other hospitals throughout the region have faulty electrical installations."

Loan for Colombian Project

The International Bank for Reconstruction and Development has made a loan of $4·5 million for the further expansion of electricity supply in Cali, one of the principal industrial centres of Colombia. A loan of $3,530,000 was received in 1950 for the building of a dam and 24,000 kW hydro-electric plant on the Anchicaya River about 30 miles from Cali (this plant is expected to be in operation shortly). The present loan will provide the Central Hidroelectrica del Rio Anchicaya with the foreign exchange needed for an additional 32,500 kW of generating capacity, consisting of a further 20,000 kW unit at the Anchicaya hydro-electric plant and the construction of a 12,000 kW thermal plant at Yumbo, just north of Cali, with additions to substation capacity. The new unit at Anchicaya should be in commercial operation in November, 1956, and the Yumbo unit by the end of 1958. When these new facilities are in operation the total generating capacity of the company's system will be 67,000 kW.

Brighton Line Signalling

On 8th May Mr. C. P. Hopkins, general manager of the Southern Region, made the final connection at East Croydon which gave continuous colour light signalling between Victoria, London Bridge and Brighton. This operation completed Stage 4 of a scheme which covers the area between East Croydon and Coulsdon North. The present stage has included the provision of three new signal boxes containing all-electric lever frames at East Croydon (103 levers), South Croydon (31 levers) and Purley (71 levers) and 16 automatic sections covering 23 track miles of continuous track circuiting. The signal box structures are of familiar Southern Region design. Besides the relay and accumulator rooms at East Croydon there is also a chamber incorporating the chief mechanical and electrical engineer's equipment for the signalling supply, but at South Croydon and Purley the signalling supplies (440 V 50 c/s) are derived from the nearby traction substations.

There are 70 signals of the multiple aspect long range type, of which 28 are carried on tubular steel posts; the remainder are carried on nine signal bridges and seven structures of cantilever or other design. The signal spacing provides for a 2½ minute headway for following stopping trains. There are 60 floodlit disc type shunting signals, solenoid operated. The 100 point machines are mostly operated from 120 V accumulator batteries at the three new signal boxes, the batteries being trickle charged by rectifiers; there are also standby rectifiers for direct point operation if necessary. Telephones connected to separate circuits are provided at all automatic and most controlled signals, giving train crews direct communication with the signal box concerned. There are 130 condenser fed track circuits, incorporating 145 impedance bonds.

The cable route almost throughout is surface concrete troughing of which there is approximately 10 miles. Signalling cables are multicore v.i.r. lead sheathed, protected and served, the number of conductors varying from 10 to 40. There are approximately 550 core miles of signalling cable, 85 pair miles of telephone cable, dry core lead sheathed and s.w. armoured, and 4¼ miles of oil impregnated paper insulated lead sheathed and s.w. armoured twin feeder cables for 480, 440 and 110 V distribution.

The whole scheme, from Battersea Park and Bricklayers Arms Junction to Coulsdon, has been spread over six years and has cost about £2,000,000. Eleven new signal boxes containing all-electric power frames (total 841 levers) replace 32 manually worked signal boxes (total 1,515 levers) over an area of 117 track miles (27 route miles). There are 400 multiple-aspect signals, nearly all 4-aspect, of which 100 are automatic, and the general signal spacing provides for a 2 to 2½ minute headway for following stopping trains. The scheme was prepared and the whole of the installation work carried out by the staff of the Southern Region signal engineer, Mr. L. J. Boucher, under his new works assistant, Mr. C. F. Challis.

The 103 lever power frame at the new East Croydon signal box and (right) the relay room

Financial Section

STOCKS and SHARES

SINCE it is generally agreed that a change of Government at the coming General Election would react unfavourably upon most sections of the Stock Exchange, the general steadiness of industrial share prices is being taken as an interesting sign of the investment community's view of the prospects. Auguries of particular significance are sought from the behaviour of the formerly nationalized steel companies' shares, which will be expected to react more smartly than most to the result, and which have been enjoying good support. Enterprise has run down, of course, to a low ebb, but pockets of activity have again been occurring as a result of individual company news.

Electricity Stocks

When the price of British Electricity 4¼ per cent stock fell at one time last week to a fraction less than 100, there existed the unusual situation that every British Government stock in issue was standing below par. The two 3 per cent Electricity stocks have been obtainable some 15 points under the price of 100 at which they must eventually be repaid. Even amid the distractions of the Election, these effects of a high Bank Rate and restricted credit are being discussed as a factor tending, at least temporarily, to put some limit on the scope for industrial and other forms of investment. When the investor can buy Government stocks to give him returns of 4 per cent and more, it seems to follow that industrial shares need something out of the common to commend them if the yield they offer is no better than, or below, that rate. By hardening to 100½, British Electricity 4¼ per cents wiped out the reproach mentioned in the first sentence above.

Higher Prices

On further consideration of the annual report, C. A. Parsons ordinary added 6s 3d to the previous week's rise of 5s. At 76s 3d they stand at the year's highest point, an unusual distinction just now in the industrial market. Reyrolles advanced by 5s a share. A rise of 2s 3d in I.C.I. was interpreted as another guide to Election opinion, parts of the chemical industry being earmarked in the Labour manifesto. With another improvement, of 2s 6d, Tube Investments have gained 10s in a fortnight, on the strength of the increase in the interim dividend for the current year.

Radios Advance

A.E.I. new ordinary shares remained in good demand, the premium rising to 29s 3d: payment in full of 40s is due early next month. At that time, the annual results of Vactric are expected: the shares have risen sharply by 3s 9d, to 17s 6d, over the past week. A more cheerful tone in radio shares

The Week's Price Changes

Company or Board	Nom. Value	Middle price 16th May	Week's Rise or Fall	Dividend Previous	Dividend Last	Yield %	1955 Highest	1955 Lowest
Gilt-edged Stocks						£ s d		
Brit. Elec. 1968/73	100	84½	−1	3	3	3 11 0	94⅜	84½
Brit. Elec. 1974/77	100	84½		3	3	3 11 0	93⅜	84½
Brit. Elec. 1976/79	100	88½	−1	3½	3½	3 19 0	98¼	87½
Brit. Elec. 1974/79	100	100½		4¼	4¼	4 4 6	109	99½
Overseas Electric Supply								
Calcutta Elec.	£1	22/-		6†	6†	5 9 0†	22/6	20/9
East African Power	£1	22/-	+6d	7	7	6 7 3	23/3	19/9
Nigerian Elec.	£1	23/6	−6d	10	10	8 10 3	27/-	22/6
Palestine Elec. "A"	£1	21/-		Nil	Nil	—	22/9	21/-
Perak Hydro-Elec.	£1	18/-		6	10	11 2 3	21/-	17/9
Equipment and Manufacturing								
Aberdare Cables	5/-	13/-	+3d	12½	17½	6 14 6	13/9	11/-
Aerialite	1/-	6/6	+3d	88½	88½	—	6/7	5/3
Allen, W. H.	£1	77/-	−2/6	15	20	5 4 0	81/6	77/-
Aron Elec. Ord.	£1	61/3		20	15	4 18 0	62/-	55/6
Assoc. Elec. Ord.	£1	67/6	+1/3	11¼	14	4 3 0	68/3	65/3
Automatic Tel. & El.	£1	72/-		15	15	4 3 4	79/6	69/-
Babcock & Wilcox	£1	73/9		12*	15	4 1 3	81/6	68/6
Baldwin, H. J.	2/-	4/9		20	20	8 8 6	5/4	4/4
Bakelite	10/-	28/9		12½	16	5 11 6	32/-	27/-
British Aluminium	£1	45/-	+3/-	10	12	5 6 9	45/6	35/3
B.I. Callender's	£1	46/9	+9d	10	10	4 5 6	55/3	44/9
B.I. Callender's 6% Pref.	£1	25/-		6	6	4 16 0	26/6	24/-
British Thermostat	5/-	25/-	+1/3	35	27½*	—	27/3	22/6
British Vac. Cleaner	5/-	16/6		25	30	9 1 10	17/9	14/3
Brook Motors	10/-	41/3		20	20*	—	42/9	39/9
Brush Ord.	5/-	8/9	+9d	6	10	5 14 3	9/6	7/7
Bulgin, A. F.	1/-	5/3	+3d	30	45	8 11 6	5/3	4/-
Burco	5/-	18/9		35	25*	6 13 3	23/-	18/9
Chloride El. Storage "A"	£1	68/9x.d.		12½	17½	5 1 9	70/-	58/6
Clarke Chapman	£1	82/6		20	20*	4 17 0	84/-	68/9
Cole, E. K.	5/-	20/-	+6d	25	27½	3 8 9*	24/6	18/3
Cossor, A. C.	5/-	9/6	+6d	10	10	5 5 3	11/3	8/9
Crabtree	10/-	30/9		17½	20	6 10 0	34/6	29/3
Crompton Parkinson Ord.	5/-	16/9		20	20	—	19/9	16/-
De La Rue	5/-	23/6	+1/9	Nil	20	4 5 2	24/3	18/9
Decca	4/-	34/6		35	56¼*	—	45/6	31/-
Desoutter	5/-	27/9		20	25	4 10 1	28/-	25/6
Dewhurst	2/-	8/-		19	24	6 0 0	8/3	7/3
Dictograph Tel.	2/-	7/-		20	20	5 14 3	7/6	6/6
Dubilier Condenser	1/-	5/-		25	25	—	5/7	3/10
E.M.I.	10/-	28/-		8	10	3 11 6	37/-	25/3
Electrical Components	5/-	15/9		20	20	6 7 0	17/6	15/3
Elec. Construction	£1	33/9		15	15	4 9 0*	37/3	31/6
Enfield Cable Ord.	£1	20/-		Nil	Nil	Nil	25/3	20/-
English Electric	£1	63/9		10	12½	3 18 6	69/3	54/3
English Electric 3¾% Pref.	£1	15/6		3¾	3¾	4 16 9	16/9	14/9
Ericsson Tel.	5/-	38/-		25†	20†*	2 12 9	38/-	29/-
Ever Ready	5/-	27/-		40	35*	6 9 9	28/9	22/3
Falk Stadelmann	£1	46/3		15	15	6 9 9	50/6	43/9
G.E.C. Ord.	£1	57/6	+1/3	11¼	12½	4 7 0	61/9	51/3
G.E.C. 6½% Pref.	£1	27/-		6½	6½	4 16 3	28/4	23/6
General Cables	5/-	15/9		30	30	9 10 6	17/-	15/9
Greenwood & Batley	£1	55/-		17½	17½	6 7 3	57/-	54/6
Hackbridge Cable	5/-	17/3		20	20	5 16 0	17/9	14/-
Hackbridge & Hewittic	5/-	24/6		20	25	5 2 0	28/9	23/9
Hall Tel. Acc.	10/-	13/3		10	10	7 11 0	13/9	11/-
Heatrae	2/-	4/6		12½	12½	5 11 0	5/9	4/3
Henley's	10/-	17/9	−3d	10½	10½	5 18 3	20/6	17/-
Holophane	5/-	17/6		20	25	7 2 9	19/9	16/-

* After scrip issue. † Free of income tax.

The above quotations are based upon middle prices in the Stock Exchange Daily Official List.

was evidenced by improvements in Ekco, Pye and Cossor. Thorn Electrics were quoted ex the 100 per cent scrip issue. Brush have been a good market at 8s 9d, and other firm features included British Thermostat (in front of the dividend announcement), De La Rue, S. Smith and British Aluminium.

Rheostatic

Rheostatic 4s ordinary shares are now quoted ex the 60 per cent scrip issue. The new shares, being transferable free of stamp duty, have been changing hands a few pence above the quotation of 11s 3d for the old. Adjusted to the amount of ordinary capital now in issue, totalling £369,600, the 22½ per cent rate of dividend distributed for 1953-54 becomes a fraction over 14 per cent, on which basis the yield on the shares works out at about 5 per cent.

in Electrical Investments

Company or Board	Nom. Value	Middle price 16th May	Week's Rise or Fall	Dividend Previous	Dividend Last	Yield %	1955 Highest	1955 Lowest
Equipment and Manufacturing—continued.						£ s d		
Hoover	5/-	47/-		45	70	7 8 10	52/6	40/-
I.C.I.	£1	44/6	+2/3	15	10*	4 10 0	45/3	38/3
Intl. Combustion	5/-	27/-		20	25	4 12 6	30/6	23/6
Johnson & Phillips	£1	44/6	−6d	15	15	6 14 9	52/6	45/-
Lancashire Dynamo	£1	61/3		14	15	4 18 0	62/6	55/3
Laurence, Scott	5/-	15/6		20	12½*	4 0 9	16/9	14/6
Lister, R. A.	£1	34/6	+1/-	12	9·3*	5 7 9	38/3	30/6
London Elec. Wire	£1	53/-	+1/6	10	12½	4 14 3	61/-	50/6
Lucas, J.	£1	43/9	+9d	10·8	7½*	3 8 9	50/6	41/6
Marryat & Scott	2/-	9/6		22½	25	5 5 3	10/4	9/6
Mather & Platt	£1	63/-	+1/-	15	13·4*	4 5 3	63/-	48/-
Metal Industries	£1	34/-		12	9	5 6 0	38/-	30/-
Midland Elec. Mfg.	£1	47/6	+1/3	15	10*	4 4 3	47/6	44/-
Morphy-Richards	4/-	29/6	+2/6	40	35*	4 15 0	31/9	27/-
Murex	£1	53/9		15	15	5 11 6	57/-	49/3
Newman Ind.	2/-	2/9		10	10	—	3/6	2/4
Oldham & Son	1/-	3/6		17½	17½	5 0 0	3/6	2/10
Parnall (Yate)	5/-	11/-	+3d	8	14	6 7 3	13/2	7/3
Parsons, C. A.	£1	76/3	+6/3	7½	10	2 12 4	76/3	56/-
Plessey	10/-	68/9		30	20*	2 18 0	76/6	57/6
Pye Deferred	5/-	35/-	+2/6	20	20*	2 17 3	40/6	28/6
Revo	10/-	13/-		27½	9*	6 18 6	15/3	12/6
Reyrolle	£1	97/6	+5/-	13¾	15	3 1 6	106/3	89/-
Rheostatic	4/-	11/3x.c.		20	22½	—	11/3	9/3
Richardsons Westgarth	5/-	13/9		15	15*	5 9 0	15/-	11/-
Scottish Cables	4/-	19/9		20	27½	5 11 3	22/6	19/6
Smith (England), S.	4/-	17/-	+9d	15	17½*	4 2 3	20/-	15/-
Southern Areas	£1	31/3		6	7½	4 16 0	34/9	27/6
Strand Elec.	5/-	9/3		17½	17½	8 19 6	9/9	8/6
Sturtevant	5/-	27/6		18·9	14·4†*	2 13 6†	27/6	21/-
Sun. Elec.	£1	33/9		15	15	8 17 9	34/6	33/9
Switchgear & Cowans	5/-	15/-		10	20	6 13 4	15/6	11/-
Taylor Tunnicliff	5/-	13/3		12½	15	5 13 3	14/-	11/3
T.C.C.	10/-	47/6		30	25*	5 5 3	48/-	41/-
T.C. & M.	£1	35/6	−6d	8½	8½	4 15 9	40/9	35/-
Telephone Mfg.	5/-	9/6		10	10	5 5 3	10/6	9/3
Thorn Elec.	5/-	18/-x.c.		12½	20	2 16 0*	18/9	13/9
Thornycroft	£1	40/6	+6d	15	15	—	44/-	34/6
Tube Investments	£1	85/-	+2/6	15	17½	4 2 3	85/9	72/6
Vactric	5/-	17/6	+3/9	Nil	10	—	18/9	12/-
Veritys	5/-	7/-		12½	12½	8 18 6	9/3	7/-
Walsall Conduits	4/-	50/-		70	70	5 12 0	55/-	50/-
Ward & Goldstone	5/-	38/9		45	50	—	43/3	37/6
Watford	2/-	7/3		22½	25	6 18 0	7/3	6/3
Westinghouse Brake	£1	98/9		16	18	3 13 0	101/9	82/-
West, Allen	5/-	14/6	+6d	17½	15*	5 3 6	15/6	8/-
Wolf Electric	5/-	18/3		17½	20	5 9 6	19/3	16/1
Trusts, Transport and Communications								
Anglo-Am Tel.:								
A. Ord.	100	75½		6	6	7 19 0	88	75½
Ord.	100	50		3¾	3¾	7 17 6	54½	50/-
Anglo-Portuguese	£1	24/3	−6d	8	8	6 12 0	25/-	21/-
Brit. Elec. Traction:								
Def. Ord.	5/-	21/6	+6d	35	50	—	24/3	19/6
Cable & Wireless:								
Ord.	£1	43/9		9	10	4 11 6	48/9	39/6
4% Loan	100	97½		4	4	4 2 0	100/-	92/-
Calcutta Trams	£1	23/6		2½†	6†	5 2 2†	25/-	20/-
Cape Elec. Trams	£1	17/6		5½	7½	8 0 0	17/6	16/6
Marconi Marine	£1	40/-		10	10	5 0 0	40/-	33/-
Oriental Tel. Ord.	£1	101/3	+1/3	16	16	—	102/6	96/6
Telephone Props.	£1	87/6	+2/6	—	20	4 11 5	90/6	80/6
Telephone Rentals	5/-	12/6	+6d	10	12½	5 0 0	12/6	9/6

Miscellaneous Matters

The £1 ordinary shares of Powers Securities Corporation, who control Balfour Beatty & Co., hardened to 35s 6d on news of the third successive increase of 1 per cent in the dividend, which is to be 8 per cent for 1954. At this rate, the yield on the shares works out at a little over 4½ per cent. Among the small priced electrical shares, moderate numbers have been on offer lately of British Electric Resistance 2s shares at about 4s 6d, and Parmiter, Hope & Sugden 1s shares at 3s 1½d. Yields on the basis of the last dividends are respectively 8·9 and 9·6 per cent. In the lists of preference shares on offer, the 5½ per cent issues of Ekco, Brush and E.M.I. have been available at 21s 6d, 19s 7½d and 19s, the respective yields being 5·1, 5·6 and 5·8 per cent.

Engineering and Lighting

The 5s shares of the Engineering & Lighting Equipment Company were well maintained at around 6s after the announcement of a final dividend of 15 per cent, and of a further advance of about 17 per cent in trading profits during the twelve months ended in March. A year ago the results were featured by the doubling of both the net profits and of the rate of dividend to 30 (including bonus of 10) per cent. This was followed by an interim dividend of 15 per cent and a three-for-two scrip issue. The latest final dividend is payable on the capital so increased to £250,000, and on this basis makes a total for 1954-55 equivalent to 21 per cent, or 9 per cent more than before. Relieved this time of the excess profits levy, the net surplus after tax (and subject to audit) of £130,000 is half as much again as the previous figure, and covers more than four times over the net amount of the dividends.

Plessey

During this month Plessey 10s shares have been showing, at times, signs of recovering the form which put the shares among the most distinguished of last year's market performers, and which carried the price up to over 75s in the early part of this year. After going down to 55s in the interval, the price has pulled up recently to 68s 9d. This latest activity was ascribed to the approach of the date for the interim dividend declaration on account of the year ending in June.

REPORTS and DIVIDENDS

Babcock & Wilcox, Ltd.—The report and accounts for 1954 now issued show a consolidated trading profit of £3,983,223, as compared with £4,072,747 for 1953, to which is added investment income of £120,930, making £4,104,153. Taxation absorbs £2,162,811, leaving a net balance of £1,941,342 (against £1,537,203), of which £1,904,228 is attributable to the parent company. It is proposed to place £600,000 to reserves and, as already announced, to pay a final ordinary dividend of 8 per cent, making 15 per cent for the year on capital of £7,524,398. For 1953 an interim dividend of 7½ per cent was paid before the one-for-two scrip issue, followed by a final dividend of 7 per cent on the present capital, making a total equivalent to 12 per cent on the current equity. The balance carried forward in the parent company's accounts is £336,422 (against £279,591 brought in).

In his accompanying statement, Mr. W. L. Fraser (chairman) says that the substantial allocations to reserves have been made because the directors believe that the rapidly changing conditions in which the business operates, in this country and abroad, can only be met by developing and extending the range of their engineering designs and manufacturing facilities. In the United Kingdom to-day there are several companies undertaking contracts for the supply of the more conventional type of boiler plant required for power stations and industrial plants. Whilst competition for the simpler type of installation is severe, their company is also best equipped to undertake the more advanced and complicated installations. It is vital to maintain this position and funds must therefore be devoted to the provision of new equipment for the manufacture of the heavy vessels and intricate components embodied in the large high pressure and high temperature plants required to-day.

In the sphere of research and development the range of investigation has, during the year, been extensive and the results are proving very useful at home and abroad. Mr. Fraser refers to the work which the company is doing in connection with the future use of nuclear energy for generating electricity, in particular for the first atomic power station now under construction at Calder Hall. After reviewing the progress made by the overseas subsidiaries, Babcock & Wilcox of Australia Pty., Ltd., Babcock & Wilcox of Africa (Proprietary), Ltd., Babcock & Wilcox (Caldeiras) S.A. Brazil, and Babcock & Wilcox de Mexico S.A. de C.V., and the home subsidiaries, Bailey Meters & Controls, Ltd., Edwin Danks & Co. (Oldbury), Ltd., and Dewrance & Co., Ltd., Mr. Fraser refers to future prospects. He says that the volume of unfulfilled orders is still satisfactory, although the betterment in raw material supplies, together with the higher output from all the works, has resulted in some reduction in the order book.

Lancashire Dynamo Holdings, Ltd.—The accounts for 1954 show a consolidated trading profit of £529,847, as compared with £495,118 for the preceding year, which with income of £10,415 from investments, makes £540,262. Taxation requires £283,872, leaving a net balance of £256,390 (against £229,907), of which £206,637 is attributable to the parent company. To this is added £439,232 brought in, making £645,869 available. It is proposed to place £100,000 to general reserve and to pay a final ordinary dividend of 11 per cent, making 15 per cent for the year. For the previous year the total distribution was 14 per cent, which included a bonus of 1½ per cent. The balance carried forward is £667,934.

In his statement which accompanies the report and accounts, Mr. H. W. Bosworth (chairman) says that at the beginning of the year under review the Willesden works of Lancashire Dynamo & Crypto, the largest unit in the group, suffered from the falling off of business at the end of 1953. The improvement in trade to which he referred last year continued and by the middle of the year all the works were fully occupied and working at their maximum capacity. Costs, however, have increased and under intense competition prices have either remained constant or been reduced. It has only been by improved methods of production that it has been possible to secure such satisfactory results.

After referring to the progress made by the other companies in the group, the chairman says that the increasing demand for their products has made it necessary to increase factory capacity in certain of the works. At Manchester the main works suffered damage last year by fire and in the consequent rebuilding a new office block is being erected and as much additional factory space as possible is being provided. The welding and fabrication plant at Liverpool is being extended while the increasing demand for electronic control in industry has necessitated the erection of a completely new factory at Rugeley on ground adjoining the present Lancashire Dynamo Electronic Products works. The Crypto works on the North Circular Road is being enlarged and a modern factory standing on 28 acres of ground has been acquired which will enable them to meet the requirements of both Nevelin Electric and Lancashire Dynamo Switchgear. Extensions have been carried out at the Leatherhead and Wimbledon works of the Foster Co., and further manufacturing space is now being added. In Australia, jointly with their existing agents, a new company is being formed, Lancashire Dynamo Coates (Pty.), Ltd. Factory space has been provided and assembly and manufacture of some of their products is now commencing. With a record volume of unexecuted orders on the books, they are reasonably assured of a satisfactory year, but in the export field they are meeting with intense competition from countries with a lower standard of living than our own.

Mr. Bosworth refers to the increase in the authorized capital, proposals for which are to be submitted to an extraordinary meeting which follows the annual meeting on 1st June. It is proposed to increase the capital of the company to £2,500,000, and in order to bring the issued share capital more nearly into line with the capital employed, the directors recommend the issue of bonus shares to the ordinary stockholders at the rate of one £1 fully paid ordinary share for every £2 ordinary stock held. This involves the capitalization of £584,332 of reserves. Permission of the Capital Issues Committee has been obtained to the issue.

Parnall (Yate), Ltd.—The main figures in the accounts for 1954 were given in our issue of 6th May. In his circulated statement, the Earl of Limerick (chairman) says that towards the end of 1954 they began the building of a warehouse for the group on land adjoining the Neasden works, and this is now nearing completion. Work on an extension at the Yate works has just begun, and when this is completed they will have more than restored the factory area which suffered damage during the last war.

During 1954 new arrangements were made with the Thor Corporation of Chicago, as a result of which Parnall (Yate) has entered into a new licence agreement covering the manufacture and sale of the "Automagic" clothes and dish washing machine, with provision for later replacement of the present type of machine. Since the end of 1954 they have acquired all the shares of Thor Appliances, Ltd. The latter company is continuing its trading with its activities closely aligned with the trading of Parnall (Yate).

Referring to the production of domestic appliances the chairman says that in 1954 they produced 2½ times the number of washing machines that were made in the previous year, and their share of the total market was more than doubled. As regards water heaters, they produced substantially more than 300,000 in 1954.

One of the most disturbing factors of 1954 and the present year is the continued rise in the price of copper, and they have had the galling experience of reducing their own costs of production, but of having to increase their heater prices substantially in order to recoup the increase in the

(*Continued on page* 903)

Reports and Dividends (*continued*)

price of copper. They already have water heaters in production, and others in design, in which the use of copper has been almost eliminated or so reduced in quantity as to have an insignificant effect on the prices of heaters. Exports of their manufactures in 1954 show an increase of 60 per cent as compared with the previous year.

W. T. Henley's Telegraph Works Co., Ltd.—The accounts for 1954 show a consolidated trading profit of £1,049,409, as compared with £1,350,003 for 1953, to which is added income from other sources, making a total of £1,242,612. After deducting depreciation of £295,309 and taxation of £432,729, the net balance is £514,574 (against £692,760). The net balance of the parent company is £491,282 (against £703,990). General reserve receives £100,000 and it is proposed to pay a final ordinary dividend of 8 per cent again making 10½ per cent for the year. It is also proposed to make a special distribution out of capital profits of 2 per cent (not subject to tax) on the ordinary stock. The balance carried forward is £801,643 (against £819,592 brought in).

The report states that trading conditions in 1954 were difficult, but the flow of orders which was low at the beginning of the year improved in the latter part; this improvement has continued into the current year and may be expected to benefit the results for 1955. Mention is also made of Sir Montague Hughman's intention to retire from the board at the annual meeting on 3rd June, and the appointment of Mr. D. Meinertzhagen as a director.

Elliott Brothers (London), Ltd., report a consolidated trading profit for 1954 of £338,462, as compared with £242,822 for the preceding year, and after meeting all charges, including £115,000 for taxation, there is a net balance of £107,878 (against £106,577), to which is added £109,367 brought in, making £217,245 available. Of this £30,200 is written off goodwill and £50,000 is transferred to general reserve. An interim ordinary dividend of 7 per cent has been paid on £308,000 stock and it is now proposed to pay a final dividend of 12 per cent on £462,000 ordinary stock. For 1953 the total distribution was 20 per cent on £220,000 ordinary stock. The balance carried forward is £89,597.

In his survey of the company's activities during the year under review, Mr. R. E. F. de Trafford (chairman) says that they are prominently engaged in process control. This branch of instrumentation is now developing into a more advanced form of these controls, namely "automation," covering a wide range of manufacturing and other activities. These new techniques have already been extensively applied to oil refineries, chemical plants and steel works and they are gradually spreading to other industries. The company makes a variety of electronic instruments as well as electronic computers, both digital and analogue. One of the largest computers built in this country was completed last year for the Royal Aeronautical Establishment at Farnborough. A new division has recently been formed to deal with nucleonic instrumentation. Work has started on the rebuilding of the Century Works at Lewisham, and at Borehamwood and Rochester other extensions are in progress. As far as the current year is concerned, business is good and the state of the order book remains high.

The Engineering & Lighting Equipment Co., Ltd.—Subject to audit, the trading profit for the year ended 31st March last is £258,917, as compared with £221,421 for 1953-54, and after deducting taxation of £129,000 the net balance is £129,917 (against £84,912). It is proposed to pay a final ordinary dividend of 15 per cent on capital of £250,000 as increased by a three-for-two free scrip issue. An interim dividend of 15 per cent was paid on the former capital. For 1953-54 there was a single dividend on the smaller capital of 20 per cent and a bonus of 10 per cent. The balance carried forward is £116,588 (against £145,956 brought in).

The reduction in the balance carried forward is due to the repayment of the preference shares and the capitalization of part of the balance brought in, which together total £127,448.

G. N. Haden & Sons, Ltd.—The accounts for 1954 were abstracted in our last issue. In his statement, Mr. G. N. Haden (chairman and joint managing director) says that the popularity of the aluminium acoustic heated ceiling marketed by the subsidiary, Frenger Ceilings, Ltd., is increasing. This method of heating has been chosen not only for every type of contemporary building, but for the modernization of old buildings. Further development and the large volume of uncompleted work in hand have called for an increase in working capital, but they anticipate that this subsidiary will soon begin to make a useful contribution to the company's prosperity. All branches have been exceptionally busy. They have extended their connections abroad and have secured a larger volume of foreign and colonial orders. At home, they have been entrusted by the Shell Petroleum Co. with the design and installation of air conditioning, heating and other services in the first projected skyscraper and wholly air-conditioned building in Britain on the south bank of the Thames.

Newman Industries, Ltd.—The annual meeting was held on 12th May, Mr. E. C. Elliott presiding in the absence abroad of the chairman, Mr. A. J. Newman.

In his circulated statement the chairman said that sales by the American company continued to improve. A marked improvement also took place in Australia. Exports again increased, about one-third being dollar-earners. A pleasing feature had been the steady expansion of the business in fractional h.p. motors. The plant and machinery division had maintained a satisfactory trade, the fabrication section had several important contracts in hand, and at Grantham more machine tools had been installed and production of aircraft engine parts had gone forward by a considerable amount.

Richard Johnson & Nephew, Ltd.—The trading results for the year to 26th March last show a group net profit, after deducting £592,732 for taxation, of £661,721 as compared with £386,159 for 1953-54. General reserve receives £537,659 and it is proposed to allocate £20,000 as a special profit-sharing bonus to workpeople. It is also proposed to pay a final ordinary dividend of 7 per cent (against 4 per cent), making 9 per cent for the year (aainst 6 per cent).

Liquidations

Rutland Electric Lamp Co., Ltd., Meteor Electric Lamp Co., Ltd., and **Nivalight (1928), Ltd.**—Winding up voluntarily. Liquidator, Mr. J. A. Deed, Farleigh House, Lawrence Lane, Cheapside, London, E.C.2, appointed 21st April. Particulars of claims to the liquidator by 20th May.

M. J. Parsons (Bournemouth), Ltd., electrical engineers.—Winding up. Liquidator, Mr. A. S. Orme, of Webb Krinks & Thomas, 1-2, Sandringham Mansions, Exeter Road, Bournemouth, appointed 29th April.

Bankruptcies

L. C. Sampson and **E. C. Tubb,** carrying on business in co-partnership as "Electro Radio Stores" at Fore Street, Gunnislake, Cornwall, electrical and television dealers.—Trustee, Mr. H. Evans, 39, St. James Street, London, S.W.1, appointed 30th April.

G. L. Searle, 186 Colne Road, Twickenham, Middx., salesman, lately residing and carrying on business as an electrical engineer at 309, Portobello Road, London, W.10.—Trustee, Mr. F. H. Langmaid, Bankruptcy Buildings, Carey Street, London, W.C.2, Official Receiver, released 29th April.

W. L. Kirby, trading as Borough Electric Co., 24, Delafield Road, London, S.E.7, lately carrying on business at Dornberg Works, Dornberg Road, Blackheath, S.E.3, electrical engineer.—Trustee, Mr. M. G. Hacker, 18, Maddox Street, London, W.1, released 20th April.

D. G. H. Hammerton and **A. J. Cummings,** carrying on business under the name of A.C.D. Electric Co., 28, West Street, Warwick, electrical engineers.—Last day for receiving proofs for dividend 25th May. Trustee, Mr. R. K. Clark, Somerset House, 37, Temple Street, Birmingham, 2, Official Receiver.

NEW PATENTS

Electrical Specifications Recently Published

The numbers under which the specifications will be printed and abridged are given in parentheses. Copies of any specification (3s 0d each including postage) will be obtainable after 22nd June from the Patent Office, 25, Southampton Buildings, London, W.C.2.

1950

3420. Electric & Musical Industries, Ltd. —Apparatus for generating and reproducing electrical signals. 31st January, 1951. (732220.)

24380. Venner Time Switches, Ltd.—Electric clocks. 28th September, 1951. Cognate application 30035, 7th September, 1950. (732344.)

26117. Standard Telephones & Cables, Ltd.—Means for checking recorded information. 26th October, 1950. (732345.) 26745. Electrical decoding circuits. 2nd November, 1950. (732346.) 28421. Electrical equipment for controlling the electrical recording of information. 21st November, 1950. (732347.)

28595. National Research Development Corporation.—Apparatus for recording electrical digit signals. 8th November, 1951. (732221.)

30574. Elliott Brothers (London), Ltd.—Electrical speed responsive warning devices. 14th December, 1951. (732222.)

1951

3707. Cosmocord, Ltd., Kelly, S., and Brownlee, J. W.—Electromechanical transducers. 7th March, 1952. (732225/6.)

22205. Smith Meters, Ltd., and Midland Bank Executor & Trustee Co., Ltd., and Charles J. A.—Prepayment mechanism for gas meters and electricity meters. 13th October, 1952. (732350.)

23098. Technograph Printed Circuits, Ltd.—Electric circuit components. 2nd October, 1952. (732437.)

1952

584. British Thomson-Houston Co., Ltd. —Electron emissive compositions. 8th January, 1952. (732439.)

1812. Licentia Patent-Verwaltungs Ges. —Relay chain circuits. 22nd January, 1952. (732354.)

2752. Foster Transformers, Ltd., formerly Foster Transformers & Switchgear, Ltd., and Jennings, R. E.—Electric arc welding systems and apparatus. 28th January, 1953. (732230.)

7153. Electric & Musical Industries, Ltd. —Electromagnetic waveguides. 11th March, 1953. (732443.)

7423. National Research Development Corporation.—Magneto-electric generators. 8th June, 1953. (732232.)

7579. Young, S. G.—Snap action electric switches. 24th June, 1953. (732357.)

9603. Postmaster General.—Carrier telephone systems. 10th April, 1953. (732446.)

10758. Philips Electrical Industries, Ltd. —Colour television cameras. 29th April, 1952. (732234.) 10759. Electron beam tubes. 29th April, 1952. (732235.) 10760. Devices for reproducing colour television images. 29th April, 1952. (732236.)

12123. Marconi's Wireless Telegraph Co., Ltd., and Buckingham, J.—Phase shift devices. 16th April, 1953. (732122.)

13311. Chromatic Television Laboratories, Inc.—Colour television voltage control system. 26th May, 1952. (732238.)

14251. General Electric Co., Ltd., and London. C. A.—Electromagnetic devices. 5th June, 1953. (732362.)

15144. General Electric Co., Ltd., and Hubbold, S.—Lighting fittings. 22nd May, 1953. (732449.)

19413. General Electric Co., Ltd., and Bloch, A.—Electrical systems for the transmission of speech. 7th August, 1953. (732370.)

19509. English Electric Co., Ltd.—Electronic overcurrent protection systems. 31st July, 1953. (732454.)

23132. Bleckmann, H., Bleckmann, A., and Damhofer, E. (trading as Bleckmann & Co.).—Electrical control system. 15th September, 1952. (732245.)

24203. Metropolitan-Vickers Electrical Co., Ltd.—Measurement of high frequency power. 19th August, 1953. (732250.)

24327. E.M.P. Electric, Ltd., and Lloyd, H.—Method of, and means for, recording electrical voltage surges. 29th December, 1953. (732375.)

25880. Metropolitan-Vickers Electrical Co., Ltd.—Pulse generating circuits. 2nd October, 1953. (732258.)

26526. General Electric Co.—Regulators for variable nozzle gas turbine power plants. 22nd October, 1952. (732459.)

25621. General Electric Co.—Resin impregnated mica paper insulation. 23rd October, 1952. (732260.)

27208. Scheid, A. M., Scheid, W. M., and Scheid, E. M. (trading as Vorwerk & Co.)—Switch devices for electrical consumer appliances. 29th October, 1952. (732381.)

29372. Metropolitan-Vickers Electrical Co., Ltd.—Electric lampholders. 19th November, 1953. (732264.)

30786. Philips Electrical Industries, Ltd. —Apparatus embodying electronic discharge tubes with photo-electric cathodes. 4th December, 1952. (732466.)

31260. Lucas (Industries), Ltd., J.—Thermally operated electric circuit-breakers. 3rd November, 1953. (732467.)

32284. Creed & Co., Ltd.—Brush holders for dynamo-electric machines. 19th December, 1952. (732470.)

1953

627. Akt.-Ges. Brown, Boveri, & Cie—Arrangement for commutating electric discharge vessels for improving the power factor in the supply system for converter connections. 8th January, 1953. (732267.)

1171. Jelson Electric, Ltd., and Moulson, J. P.—Electric switch and thermal cut-out apparatus. 13th January, 1954. (732393.)

1359. General Electric Co., Ltd., and Thorne, A. R. H.—Electric switches, contactors or the like having bridging contacts. 15th January, 1954. (732496.)

1928. Smith & Sons (England), Ltd., S.—Negative feed-back systems incorporating magnetic amplifiers. 15th January, 1954. (732396.)

2431. Aktiebolaget Fullmanen.—Electrode for galvanic batteries especially accumulators. 28th January, 1953. (732270.) 2432. Method for producing electrodes for galvanic batteries especially accumulators. 28th January, 1953. (732271.)

2695. Jackson Electric Stove Co., Ltd.—Domestic electric cookers. 11th November, 1953. (732499.)

2788. Marconi's Wireless Telegraph Co., Ltd.—Electrical filters. 25th November, 1953. (732273.)

3235. Cole, Ltd., E. K., and Cox, V. J.—Electrically driven tuning forks. 5th February, 1954. (732500.)

4527. Air Preheater Corporation.—Overload protection for power supplies of an electrostatic precipitator. 18th February, 1953. (732277.)

5253. English Electric Co., Ltd.—Withdrawable electric apparatus. 19th February, 1954. (732501.)

5267. Naamlooze Vennootschap Philips' Gloeilampenfabrieken.—Thermal regenerators. 25th February, 1953. (732502.)

6061. Murphy Radio, Ltd.—Television receivers. 4th June, 1954. (732505.)

6757. Landis & Gyr Akt.-Ges.—Automatic electric circuit-breakers. 11th March, 1953. (732159.)

6838. Standard Telephones & Cables, Ltd.—Electric impedance networks. 12th March, 1953. (732507.)

7829. Standard Telephones & Cables, Ltd.—Stereoscopic television system. 20th March, 1953. (732472.)

7912. Philips Electrical Industries, Ltd. —Cameras for use in medical X-ray photography. 23rd March, 1953. (732402.)

9392. Patelhold Patentverwertungs & Elektro-Holding Akt.-Ges.—Variable inductive coupling devices. 7th April, 1953. (732171.)

10476. Telefunken Ges. für Drahtlose Telegraphie.—Direct current thermionic valve amplifiers. 16th April, 1953. (732290.)

10572. Standard Telephones & Cables, Ltd.—Electrolytic condenser. 17th April, 1953. (732174.)

11107. Sierra Electronic Corporation.—Voltage regulator. 22nd April, 1953. (732482.)

11453. Telephone Manufacturing Co., Ltd.—Party-line metering in automatic telephone exchange systems. 8th March, 1954. (732178.)

11603. Fuller, L., and Sudlow, E. W.—Electric secondary batteries. 23rd April, 1954. (732404.)

12447. Elcon Manufacturing Co.—Electrical connector sockets. 5th May, 1953. (732407.)

12461. Kaye, E., Sharp, J. R., and Arnot, A. E. R.—Electric motor regulating apparatus. 4th May, 1954. (732408.)

13603. General Motors Corporation.—Switch mechanism particularly for electrical traction vehicles. 15th May, 1953. (732301.)

15234. Socony-Vacuum Oil Co., Inc.—Means for eliminating phase distortion for use in the recording of seismic waves. 1st June, 1953. (732188.)

18845. National Research Development Corporation.—Electrical multivibrator circuits. 8th November, 1951. (732310.) 18846. Electronic digital computers. 8th November, 1951. (732311.)

19644. Siemens-Schuckertwerke Akt.-Ges.—Soldering devices. 15th July, 1953. (732315.)

19952. Télémecanique Electrique.—Electrical circuit-breaker apparatus. 17th July, 1953. (732196.)

20128. Soc. Anon Francaise du Ferodo.—Circuits for controlling electromagnetic clutches. 20th July, 1953. (732513.)

21486. General Electric Co.—Remote control systems. 4th August, 1953. (732320.)

24653. Ateliers de Constructions Electriques de Charleroi.—Method of synchronization for magnetic sound recorders. 7th September, 1953. (732520.)

24919. Allmänna Svenska Elektriska Aktiebolaget.—Automatic electric regulators. 9th September, 1953. (732207.)

25341. Nilsen & Co. Proprietary, Ltd., O. J.—Cartridge type fusible electric cut-outs. 14th September, 1953. (732428.)

25996. Standard Telephones & Cables, Ltd.—Radio communication systems including repeaters, and employing frequency modulation. 21st September, 1953. (732522.)

28432. General Motors Corporation.—Protective shields for enclosing the connection between a spark plug and an electric cable. 15th October, 1953. (732525.)

30437. Allmanna Svenska Elektriska Aktiebolaget.—Measurement of intensity and transmission of impulses through the same transmission line. 4th November, 1953. (732527.)

33000. Philips Electrical Industries, Ltd.—X-ray tubes. 27th November, 1953. (732335.)

36006. Camarero, J. C.—Voltage regulator. 28th December, 1953. (732530.)

CONTRACT INFORMATION

Accepted Tenders and Prospective Electrical Work

CONTRACTS OPEN

Where "Contracts Open" are advertised in our "Official Notices" section the date of the issue is given in parentheses.

Australia.—27th June. Electricity Commission of New South Wales, Sydney. Four 15 MVA 16 kV transformers. (E.S.B. 9518/55. Ten/13706.)*

Dearne.—31st May. U.D.C. Street lighting scheme. (See this issue.)

Goole.—28th June. Borough Council. 300 kVA diesel alternator and duplicate busbar switchgear for Pollington Waterworks. T. Waterfall, borough surveyor.

Heston and Isleworth.—3rd June. Corporation. Street lighting equipment. (See this issue.)

Kircubbin (Co. Down).—9th June. County Education Committee. Electrical installation in Glastry Intermediate School. A. W. G. Holt, consulting engineer, 74, South Parade, Belfast.

Leyton.—26th May. Borough Council. Electrical contractors who wish to be placed on an approved list to carry out various works for the Council should apply to the borough surveyor, Town Hall.

New Zealand.—17th June. Post and Telegraph Department, Wellington. 50 transmitter-receivers for vehicles. (E.S.B. 10086/55. Ten/13807.)*

Peterborough.—17th June. Joint Education Board. Electrical installation work at County Grammar School for Girls. (See this issue.)

Peterlee (Durham).—6th June. Development Corporation. Electrical installations in 210 houses on the Acre Rigg site. Chief architect, Shotton Hall, Castle Eden, Co. Durham.

Seaton Valley (Northumberland).—U.D.C. Electrical installations in 64 houses at Seghill. Surveyor, Council Offices, Seaton Delaval.

Southern Rhodesia.—15th June. Umtali Electricity Department. Six 50 A, 11 kV oil circuit-breaker reclosures. (E.S.B. 10013/55. Ten/13736.)*

Tillicoultry.—8th June. Burgh Council. Street lighting equipment. (See this issue.)

United States.—7th June. Bureau of Reclamation, Denver, Colorado. 115 kV power circuit-breaker for Belden substation. (E.S.B. 9526/55. Ten/13747.)*

23rd June. Corps of Engineers, U.S. Army, Oregon. Station service generators for Dallas Dam powerhouse. (E.S.B. 9617/55. Ten/13811.)*

Uruguay.—3rd June. Administracion National de Combustibles, Alcohol y Portland. Eight secondary batteries for diesel electric locomotives. (E.S.B. 10060/55. Ten/13746.)*

Wakefie'd.—City Council. Street lighting equipment. (See this issue.)

Watford.—16th June. Corporation. Improved lighting at Town Hall offices. (See this issue.)

* Specifications may be inspected at the Export Services Branch, Board of Trade, Lacon House, Theobald's Road, London, W.C.1 (Chancery 4411; extension 769).

ORDERS PLACED

Dudley.—Streets, Transport and Lighting Committee. Street lighting equipment and cable. New Birmingham Road (£6,331).—Midlands Electricity Board.

Ilford. — Public Health Committee. Recommended. Diesel alternator set for Roden Street pumping station (£7,191).—Crossley Bros.

Housing Committee. Electrical work in pre-war Council houses, Fencepiece estate: Section 1 (30 houses; £1,117).—The Glade Electric; Section 2 (35 houses; £1,363); Section 3 (39 houses; £1,502) and Section 4 (28 houses; £1,102).—B. Winters & Son.

Sheffield.—Watch Committee. Sodium lanterns (140 W).—Engineering & Lighting Equipment Co. (£1,200) and Concrete Utilities (£1,200). Transformers.—Concrete Utilities. Control gear boxes and capacitors.—Philips Electrical.

WORK IN PROSPECT

Particulars of new works and building schemes for the use of electrical installation contractors and traders. Publication in this section is no guarantee that electrical work is definitely included. Alleged inaccuracies should be reported to the Editors.

Acton.—Additional storeys to premises in Western Avenue, W.3; Waring & Gillow, Ltd., 164, Oxford Street, W.1.

Barnes.—Flats (22), High Street and Grove Road; borough surveyor.

Belfast.—Secondary intermediate school at Dunlambert and intermediate school at Grosvenor High School, Roden Street; education architect, 40, Academy Street.

Belford.—Houses (23), Bamburgh, for R.D.C.; R. Carse and Son, Ltd., builders, Oldgate, Morpeth.

Berkhamsted (Herts).—Flats (44); R. E. Hulse, surveyor, Civic Centre.

Billingham-on-Tees.—Secondary modern school (£146,600); county architect, Court Lane, Durham.

Birmingham.—Factory premises, Dartmouth Street; Wilson Lovatt & Sons, Ltd., Clarence Street, Wolverhampton.

Blaydon (Co. Durham).—Houses (158), Stella Hall; W. Leech, Ltd., builders, 2, Clayton Street, Newcastle-on-Tyne.

Blyth.—Houses (41), Laverock Hall Road; D. W. Foster, borough engineer.

Border.—Houses (80), Blackwell; Thos. Armstrong, Ltd., Keswick.

Bradford.—Flats (192), Thorpe Edge estate; John Laing & Son, Ltd., Dalston Road, Carlisle.

Bridlington.—Houses (52), West Hill estate; S. Briggs, town clerk, Town Hall.

Bristol.—Office block, Rupert Street; Morris de Metz, architect, 2, Ludgate Hill, London, E.C.4.

Works, Brislington estate; City Metal Works (Bristol), Ltd., sheet metal workers, 2, Twinnell Road, Bristol, 5.

Carlisle.—Bakehouse factory, Harraby, for W. G. Robertson, Ltd.; John Laing and Sons, builders, Dalston Road, Carlisle.

Carmarthen.—General hospital, Glangwili; Welsh Regional Hospital Board, Maesycoed Road, Rhiwbina, Cardiff.

Chesterfie'd.—Proposed cinema at Newbold; Victoria Enterprises, Ltd., Knifesmith Gate, Chesterfield.

Cleethorpes.—Two blocks of three-storey flats and maisonnettes, Beacon Hill; A. B. Cooper, borough surveyor, Council House.

Dagenham.—Factory, Hainault estate; Art Steel Equipment Co., Ltd., 33/35, Montgrove Road, London, N.5.

Darlington.—Secondary school for boys, Ryhope Road (£217,500) and engineering workshops and laboratories at College of Further Education (£98,117); borough architect.

Dewsbury.—Phase 1 extensions to Dewsbury and Batley Technical and Art College; James Green, clerk to the Governors, Education Offices, Halifax Road.

Doncaster.—Technical high school for boys (£169,242); W. Simpkins, Ltd., Sheffield.

Central vehicle maintenance workshop at North Bridge (£18,400); borough architect.

Dover.—Flats (233), Marine Parade; Dalgliesh & Pullen, architects, 17, Fitzhardinge Street, London, W.1.

Durham.—Public library, Seaham, and community centre, Felling; county architect, Court Lane, Durham.

Essex.—Clinics at Loughton, Manningtree, Brentwood and Ilford; county architect, Shire Hall, Chelmsford.

Gosport.—Police station, court house and offices; county architect, The Castle, Winchester.

Halifax.—Fire station, Keighley Road; borough engineer.

Harlow.—Hospital; regional architect, North East Metropolitan Hospital Board, 3, Queen Anne Street, London, W.1.

Harrogate.—Extensions at Ashfield College; Needham, Thorp & White, architects, 6, High Petergate, York.

Hexham.—Houses (24), Haydon Bridge; W. Dixon and Son, architects, Collingwood Street, Newcastle-on-Tyne.

High Wycombe.—Factory adjoining The Limes; W. H. Deane (High Wycombe), Ltd., hospital furniture manufacturers, Wooburn Green, Bourne End.

Liverpool.—Works extensions (£100.000); Goodlass, Wall & Co., Ltd., Wellington Buildings, The Strand.

Development of new neighbourhood unit at Lee Park (about 900 houses); city engineer, Municipal Buildings, Dale Street, 2.

London.—Six-storey ward block, St. Bartholomew's Hospital, Smithfield; Adams, Holden & Pearson, architects, 38, Gordon Square, W.C.1.

Works extensions, Cricklewood; Anchor Glass Co., Ltd., North Circular Road, N.W.2.

First phase of scheme for rebuilding Lambeth Hospital, Brook Drive, London, S.E.11 (£274,000); South East Metropolitan Hospital Board, 11, Portland Place, W.1.

Maidstone.—Houses (38), Shepway Farm estate; borough surveyor, Palace Avenue.

Manchester.—Extensions to factory at Baring Street, Ardwick, for David Moseley & Sons, Ltd.; Mark Pharoah, 13, Fairview Avenue.

Large new departmental store at Deansgate; C.W.S. Architect's Department, 1, Balloon Street.

Houses for T. C.; Roy & Partners, 25, Cross Street (82 on Langley estate and 159 at Wythenshawe) and A. Locke (1940), Ltd., 166, Higher Road, Urmston (126 on Langley estate and 150 at Wythenshawe).

Erection of Broad Oak Lane Primary School, Didsbury; G. & J. Seddon, Ltd., Little Hulton, Nr. Bolton.

Middlesbrough.—Motor showrooms for Murray & Charlton, Ltd., Newcastle; Marsh Builders, Ltd., 105, Bishopton Road, Stockton-on-Tees.

Mitcham.—Baptist church, Pollards Hill; W. E. Norman Webster & Son, architects, 1a, Station Street, Spalding.

Newcastle-on-Tyne.—Additions to the optical works of Sir Howard Grubb Parsons and Co., Ltd., Walkergate, Newcastle.

Additions to library buildings at King's College (£300,000); Easton and Robertson, architects, 53, Bedford Square, London, W.C.1.

Newcastle-under-Lyme.—Shops and offices, Hassell Street; borough surveyor, Lancaster Buildings, Newcastle, Staffs.

Northumberland.—Civil defence training centre at Morpeth (£56,000); county architect, County Hall, Newcastle-on-Tyne.

Penistone.—Houses (20), Shrewsbury Road site; Hey & Murfin, Ltd., Summer Lane, Wombwell.

Penzance.—Flats (56); borough surveyor, Municipal Offices.

Reading.—Works and offices, Manor Farm estate; Mills Scaffold Co., Ltd., Trussley Works, London, W.6.

Branch library at Tilehurst (£23,250); G. F. Darlow, town clerk, Town Hall.

Rowley Regis.—Houses (34), Tividale Hall estate; architect, Municipal Buildings, Old Hill, Staffs.

Rugby.—Erection of new factory; Autoflow Engineering, Ltd., optical engineers, 118, Clifton Road, Balsall Heath, Birmingham, 12.

Salford.—Cromwell Secondary Modern School; Cruikshank & Seward, architects, 196, Deansgate, Manchester.

Seaham.—Houses (40); U.D.C. surveyor.

Sedgley.—Flats (20), Summit Place, for U.D.C.; Joseph Webb & Co., Ltd., 1, Ivy House Lane.

Sheffield.—Houses (76), Greenhill/Bradway estate; Bailey & Martyn, Ltd., 44, Bank Street.

Skegness.—Houses (60), shops and flats as first development of Sundial estate; U.D.C. surveyor.

Smethwick.—Erection of Sandwell County Secondary School; C. Green & Sons, Ltd., 132, Monument Road, Birmingham, 16.

South Hornchurch.—Houses (156), Elm Park estate; The Elm Park Development Co., Ltd., St. Anne's Hill, Chertsey.

South Shields.—Development of site in Maxwell Street for erection of factory; Elsy and Gibbons, Ltd., copper cylinders, tanks, boilers, etc., Havelock Street.

Stevenage.—Works extensions; British Visqueen, Ltd., Six Hills Way.

Alleyn's Grammar School (£155,000); M. & F. O. Foster & Co., Ltd., builders, Waldworth Road, Hitchin.

Stockton-on-Tees.—Works additions, Beaumont Street, for Pickering and Co., Ltd.; M. Trotter, architect, 134, High Street.

Works additions, Church Road, for Harker and Son, Ltd.; F. W. Turnbull, architect, White House, Carlton.

New works block; Hugill Forge and Engineering Co., Ltd., Church Road, Stockton.

Strood.—Houses (100), High Halstow; F. Parham, Ltd., contractors, 1a, Eva Road, Gillingham, Kent.

Sudbury.—Houses (107), Woodhall estate; borough surveyor, Municipal Offices, Belle Vue, Sudbury, Suffolk.

Sunderland.—Increased accommodation at special school, Brampton; borough architect, Grange House, Stockton Road.

Theydon Bois (Essex).—County primary school (£45,000); H. Conolly, county architect, County Offices, Chelmsford.

Tynemouth.—Factory additions at North Shields for De La Rue, Ltd.; Turnbull and Partners, architects, 29, Ludgate Hill, London, E.C.4.

Additions to laboratories, etc., at Cullercoats for the Council of King's College; Edwards and Partners, architects, 52, Eldon Place, Newcastle-on-Tyne.

Houses (39), Monkstone estate; M. J. Liddell and Son, builders, 36, Great North Road, Newcastle-on-Tyne.

Houses (18); borough engineer, 16, Northumberland Square, North Shields.

Ulverston.—Erection of secondary modern school at Cartmel; Christopher Martindale, architect, Cathedral Chambers, Castle Street, Carlisle.

Wem.—Dwellings (89), Aston Road; Ronald S. Biggins, architect, 123, Boughton Road, Chester.

West Hartlepool.—Flats (114) for the T.C. Builders; C. M. Yuill, Ltd., Villiers Street, West Hartlepool (54); Taylor and Evans, Elwick Road, West Hartlepool (36); and W. W. Brazell, Ltd., Raeburn Street, West Hartlepool (24).

NEXT WEEK'S EVENTS

Organizers of electrical functions are advised to make use of the "Electrical Review" clearing house, Room 221, Dorset House, Stamford Street, London, S.E.1, to ascertain that proposed dates do not clash with others already arranged

Monday, 23rd May

CHRISTCHURCH. — A.S.E.E. Southampton Branch. Visit to De Havilland Aircraft Co., Ltd.

Tuesday, 24th May

SANDMOOR.—Sandmoor Golf Course. I.E.E. North Midland Centre. Annual golf competition.

Wednesday, 25th May, to Saturday, 28th May

BELFAST.—Balmoral. Royal Ulster Agricultural Show.

Thursday, 26th May

CARDIFF.—At the South Wales Institute of Engineers, Park Place, 6 p.m. Association of Mining Electrical and Mechanical Engineers, South Wales Branch. Annual general meeting.

CHESTER.—Incorporated Plant Engineers, Merseyside & N. Wales Branch. "Corrosion of Metals, and Methods of dealing with this Problem," by Dr. M. Cowan.

DUNDEE.—Queen's College, 7 p.m. I.E.E. North Scotland Sub-Centre. Scottish Centre annual general meeting, followed by "The Development of High-Voltage Cables," by J. S. Hastie.

LONDON.—Connaught Rooms, W.C.2, 12.30 for 12.50 p.m. Batti-Wallahs' Society. Luncheon. Speaker, Air Marshal Sir Victor Goddard.

NOTTINGHAM. — Reform Club, Victoria Street, 7 p.m. Nottingham Electrical Club. Annual general meeting.

SHEFFIELD. — Grand Hotel, 7.30 p.m. Incorporated Plant Engineers, Sheffield & District Branch. "Illumination."

Friday, 27th May

BIRMINGHAM.—Imperial Hotel, 7.30 p.m. Incorporated Plant Engineers, Birmingham Branch. "Steam in Industry," by L. A. Bawden.

SHEFFIELD. — Grand Hotel, 6.30 p.m. Institute of Metal Finishing, Sheffield & North-East Branch. "Research in Electrodeposition—a Review of the Past and Predictions for the Future," by Prof. J. W. Cuthbertson.

CATALOGUES AND LISTS

BROODER UNITS.—Leaflet covering the "Broodaway" range of units for poultry and pig rearing.—**Metway Electrical Industries, Ltd.,** Metway Works, Kemp Town, Brighton, 7.

CABLE FITTINGS.—16-page illustrated catalogue (B.H.34) dealing with the company's cable binding system, cable markers, grommets and other accessories.—**Hellermann, Ltd.,** Crawley, Sussex.

CIRCUIT BREAKERS.—Illustrated booklet (200) introducing a new range of high rupturing capacity air circuit breakers for l.v. systems.—**J. G. Statter & Co., Ltd.,** 82, Victoria Street, London, S.W.1.

CONTROL GEAR.—Brochure illustrating a selection of the company's range of auxiliary and limit switches.—**Dewhurst & Partner, Ltd.,** Inverness Works, Hounslow.

DISTRIBUTION BOARDS. — Leaflet dealing with surface and flush mounting distribution boards.—**Varilectric, Ltd.,** 10, Melon Road, London, S.E.15.

ELECTRICAL EQUIPMENT.—A 26-page booklet describing a range of the company's products including components for the radio, aircraft and communications industries.—**The Plessey Co., Ltd.,** Ilford, Essex.

ELECTRO-PRECIPITATION. — 36-page illustrated technical booklet dealing with high efficiency electro-precipitation equipment.—**Simon-Carves, Ltd.,** Cheadle Heath, Stockport.

ELECTRON DIFFRACTION CAMERA.—Illustrated leaflet (E.156/1) dealing with the redesigned Finch electron diffraction camera for research laboratory work connected with thin films, crystal structures and monomolecular layers.—**W. Edwards & Co. (London), Ltd.,** Manor Royal, Crawley, Sussex.

FANS.—Brochure (P.33) illustrating and describing the company's centrifugal fans and dust collectors.—**Prat-Daniel (Stanmore), Ltd.,** Dalston Gardens, Stanmore, Middlesex.

IMPREGNATORS. — Illustrated folder giving technical information and particulars regarding high vacuum and pressure impregnators.—**Blickvac Engineering, Ltd.,** 96-100, Aldersgate Street, London, E.C.1.

INSTRUMENTS.—Illustrated and priced catalogue and an application schedule of the Bruel & Kjaer electronic instruments.—**Rocke International, Ltd.,** 59, Union Street, London, S.E.1.

Leaflet with technical specification and description of the company's pulse height analyser.—**Sunvic Controls, Ltd.,** 10, Essex Street, Strand, London, W.C.2.

16-page illustrated booklet on the company's industrial instruments and a leaflet (361) dealing with the K.U. flow meter for steam, air, gas, water or other fluids.—**George Kent, Ltd.,** Luton, Beds.

Leaflet giving particulars of the company's limit bridge for resistance measurement and thermometer bridge for the direct measurement of temperature rise.—**Clare Instrument Co.,** 39, Victoria Street, London, S.W.1.

INSULATION TAPE.—Technical data of silicone rubber glass cloth insulation tape manufactured by the company.—**Dunlop Rubber Co., Ltd.** (G.R.G. Division), Cambridge Street, Manchester, 1.

METALS.—47-page technical catalogue dealing with Wilco-Wiggin thermometal and five booklets on other alloys in the company's range of products.—**Henry Wiggin & Co., Ltd.,** Wiggin Street, Birmingham, 16.

MOTORS.—19-page catalogue (B.1) giving outputs and dimensions of the company's range of standard a.c. industrial electric motors together with separate price list (A.1). —**Lancashire Dynamo & Crypto, Ltd.,** Trafford Park, Manchester,17.

PRINTED CIRCUITS.—Folder giving information on the preparation of "Plasmet" printed circuit layouts.—**Printed Circuits, Ltd.,** Whadcoat Street, London, N.4.

RELAY EQUIPMENT.—Five leaflets on coaxial and other relays, a process timer and the company's type E.L.U. automatic earth leakage equipment.—**Londex, Ltd.,** Anerley Works, London, S.E.20.

SOLDERS.—22-page booklet entitled "Modern Solders" dealing with the uses of cored solders and including tables giving data on eleven different alloys in which "Ersin Multicore" solder is manufactured.—**Multicore Solders, Ltd.,** Hemel Hempstead, Herts.

SWITCHGEAR.—Pamphlet (1249) covering the company's Class SA air-break switchgear in ratings up to 150 MVA at 3,300 V.—**A. Reyrolle & Co., Ltd.,** Hebburn, Co Durham.

TEST EQUIPMENT.—Leaflet (2310) illustrating and describing a range of high voltage test sets manufactured by the company.—**Foster Transformers, Ltd.,** South Wimbledon, London, S.W.19.